Supreme Court, U. S.
FILED
SEPT 19 1980
MICHAEL RODAK, JR., CLERK

No. 80-437

In the Supreme Court of the United States

OCTOBER TERM, 1980

GEORGE ARSHAL, Petitioner

v.

THE UNITED STATES

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF CLAIMS

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Petitioner

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THE UNITED STATES COURT OF CLAIMS

QUESTION PRESENTED

Whether a claim to flight control apparatus becomes unpatentable under 35 U.S.C. 101 because it involves numerical computation.

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OPINIONS BELOW

The opinion of the Court of Claims, *Arshal v. United States*, Ct. of Cl. No. 431-75, March 19, 1980, (Appendix 1, *infra*, 1a-44a) is presently unpublished. The opinion of the Trial Division of the Court of Claims (Appendix 2, *infra*, 45a-108a) is unreported.

JURISDICTION

The judgment of the Court of Claims was entered on Mar. 19, 1980 (Appendix 1, *infra*, 1a). Motion for rehearing and rehearing *en banc* was denied on June 27, 1980 (Appendix 3, *infra*, 109a). The jurisdiction of this Court is invoked under 28 U.S.C. 1255.

STATUTES INVOLVED

1. 35 U.S.C. 101, which provides that:

   Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

2. 35 U.S.C. 112, which provides that:

   The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and

shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention. A claim may be written in independent or dependent form, and if in dependent form, it shall be construed to include all the limitations of the claim incorporated by reference into the dependent claim

An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.

STATEMENT

The petitioner received U.S. Patent No. 3,319,052 for a Directional Computer on May 9, 1967. The invention is used to furnish command directions to the flight control systems of missiles or aircraft.

Flight control systems usually establish directional control over a kinematic quantity, such as the axis of the vehicle or the measured velocity or acceleration of the vehicle. A directional command is supplied and the vehicle is driven to eliminate any directional disparity

between the command and the quantity being controlled. To be wholly useful, the command direction should be capable of providing a wide range of geometric or rate of change characteristics relative to space. It is through a progression of such command directions that a specifically desired trajectory or other flight condition is produced.

In the prior art, the directional commands commonly referred to the gimbals of a gyroscopically stabilized reference body and commanded the gimbal angles.[1] The prior art also utilized vehicle fixed gyroscopes and commanded the direction of the vehicle by means of precessing the gyros. In either case, the directional commands required a flight control response in three degrees of freedom, *i.e.* in pitch, yaw, and roll.

Petitioner's invention (claims 2 and 6, Appendix 4,) dispenses with angle commands and produces the directional command as a vector. The vector consists of a gyroscopically stabilized reference frame and a set of

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[1] The gyroscopically stabilized reference body provides the vehicle with a space fixed reference frame. The reference body is equipped with gyroscopic measuring apparatus and is gimbal mounted for three degrees of rotational freedom. Control motors for exerting torque on the reference body are attached to the gimbals. The control motors respond to the gyroscopic measurements to suppress the angular movement of the reference body indicated by the measurements. The gimbal angles are independently determined by the orientation of the vehicle relative to the reference body.

signals referred to the axes of the reference frame.[2] The axes simply direct the signals and establish a resultant vector.

The command vector, which is identified as an output vector or output direction, is constructed to receive a given input vector as its angular velocity relative to space, *i.e.*, the output vector is rotated by an input vector. The input vector completes the concept. Different input vectors, of which several useful examples are given in the patent specification, are selectively used to generate the output vector. The output thus acquires the geometric or rate of change properties relative to space that are desired for the kinematic quantity being controlled in the vehicle.

Outstanding attributes of petitioner's invention are that:

1. It requires a control response to its directional command in only two degrees of freedom rather than the three demanded by the prior art.

2. It is capable of generating directional commands having any desired geometric or rate of change properties.

These technological results are not merely of academic

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[2] Claims 2 and 6, which are the claims at issue, represent the gyroscopically stabilized reference frame as a "physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity." This element encompasses the apparatus discussed in footnote 1.

interest. They are embodied in the Poseidon and Trident ballistic missile systems.[3]

The control simplification obtained by the Poseidon and Trident missiles by their use of petitioner's invention is manifested in the presence of a single propulsion nozzle in each of their boost stages of flight. The single nozzle suffices because it has to support only pitch and yaw control, which it accomplishes with the pitch and yaw deflections available to it. By comparison, the prior art ballistic missiles, which worked with gimbal angles, had to utilize a heavier and costlier system of multiple propulsion nozzles in order to service their additional roll control requirement. The multiple nozzles further degraded the missile's performance by diverting a significant amount of missile volume from propellant capacity into extra passageways for the exhaust gases.

The Poseidon and Trident missiles are used and manufactured for the United States by the Department of the Navy. Petitioner sought compensation for the government's patent infringement in the United States Court of Claims, as provided by 28 U.S.C. 1498(a).

The Court of Claims subsequently classified petitioner's invention as the equivalent of a computer program or a method of calculation and invoked *Gotts-*

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[3] **The Trial Judge in the Court of Claims found claims 2 and 6 infringed by Poseidon and Trident (Appendix 2, *infra*, 81a-107a) and this finding stood uncontested before the review panel of the Court of Claims.**

chalk v. Benson, 409 U.S. 63 (1972), as authority for invalidating the patent.

REASONS FOR GRANTING CERTIORARI

The decision of the Court of Claims to invalidate the patent is unreasoned and unprecedented.

1. THE COURT OF CLAIMS STRIPPED THE CLAIM OF ESSENTIAL PARTS AND FORCED IT TO APPEAR AS BENSON:

In applying *Benson*, the Court of Claims isolates an element of the claim dealing only with numerical computation, calls the element unpatentable, *per se*, and then extends this conclusion to the whole claim. As its rationale for this act, the Court says that the gyroscopically stabilized reference frame "is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*" because it is "essential to the performance of the computation." (Appendix 1, *infra*, 19a-21a.) That the gyroscopically stabilized reference frame is patentable subject matter is undisputed. The Court of Claims seeks to establish the principle that patentable subject matter, however essential, becomes unpatentable when it is combined with numerical computation. The Court's position is incompatible with the statutory provision, 35 U.S.C. 101, that: "Whoever invents or discovers any new and useful process, machine, manufacture, * * *, or *any new and useful improvement thereof*, may obtain a patent therefor, * * *." [Emphasis added.]

The Court of Claims also makes an improper finding of pre-emption. It looks exclusively at the element of the claim that deals with numerical computation, the same one already referred to, and says that:

> [T]he "means plus function" language encompasses any and every type of apparatus or machine which could be used to implement the claimed equation and, therefore, the element is not "limited to any particular apparatus or machinery." * * * The element truly does, in the *Benson* sense, wholly pre-empt the mathematical formula which it embodies. (Appendix 1, *infra*, 19a).

This is the court's entire conclusion on the question of pre-emption. It is an irrelevant conclusion. An element of a claim is not qualified to pre-empt anything. The test of pre-emption belongs to the claim *as a whole*. That the whole claim is limited to gyroscopically controlled apparatus (machinery) is absolutely established. The computational element simply brings a further limitation.

The "claimed equation," *supra*, referred to by the lower court expresses a law of kinematics that is descriptive of all rigid bodies. It states the rule by which a direction defined in a rigid body is changed by the angular velocity of the body.[4]

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[4] A pair of marks, a line, a flat, or in general, any kind of geometric identification serves to define direction in a rigid body.

The claims utilize the equation to establish the relationship between the input and output vectors. Their embodiment of the relationship involves both a rigid body and numerical computation, but a rigid body unsupported by numerical computation also embodies the relationship. These two ways of embodying the same fundamental relationship are not so different that one of them is a "calculation" and the other is not. They are both structural relationships.

The Court of Claims has indiscriminately adopted the view that a mathematical equation is inevitably a formula or method of calculation. That view is altogether incorrect.[5] If allowed to prevail, the lower court's view of equations will frustrate much of the technological interchange and progress which the patent system is designed to encourage. As already demonstrated in this case, a mathematically treated

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[5] Mathematics is the natural language of the physical sciences. It embraces geometry as well as numbers. It holds the power of description over the form and shape and the physical properties of all substance. It describes the interactions between measurable physical quantities. It connects physical laws with physical circumstances. The equation is its mode of expression.

Equations sometimes express formulas or methods of calculation. They also express definitions, identities, relationships, solutions, conditions, and constraints, including representations of bodies, surfaces, and boundaries. As in the patent at issue, the equation is also used to specify physical and functional requirements.

patent disclosure is presently viewed as an open invitation to attack the patent as a method of calculation regardless of what it is. That reaction can only lead to a severely repressed use of mathematics in patent disclosures and in other publications on the same inventions. It brings the irony that the language most competent to describe or specify a device is disallowed.

2. THE COURT OF CLAIMS DID NOT RECOGNIZE THE TECHNOLOGICAL USEFULNESS OF THE CLAIMED INVENTION:

The case record clearly establishes the technological usefulness of the claimed invention in the Poseidon and Trident missile systems, as noted above. The relevant facts stand acknowledged by the opposing party in this case and were fully produced before the Court of Claims. This body of evidence alone suffices to establish the claimed invention as patentable, technological art. It was not properly considered by the Court of Claims.

Also, this Court set forth the obligation to read the claims in the light of the specifications, *United States* v. *Adams*, 383 U.S. 39, 48-49 (1966). The lower court did not do so. It failed to recognize the patent's extensive discussion on the character and use of the invention generally and the input vectors in particular. It injected its own improper definition of vectors into the case despite the fact that the prior-art and state-of-the-art references in the case, including those of the accused structures (the Poseidon and Trident missiles),

defined the vector wholly in agreement with petitioner's definitions in the specifications and in the claims of the patent.

3. THE COURT OF CLAIMS MISREAD THE PATENT CLAIMS:

The question of how claims should be read when they involve numerical computation is the seat of much of the controversy surrounding *Gottschalk* v. *Benson*, *supra*, and *Parker* v. *Flook*, 437 U.S. 584 (1978). The Court of Claims misused the principles of *Benson* and *Flook* by its arbitrary analysis of the claims.

The statutes indicate how claims should be read. 35 U.S.C. 112 requires that:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

35 U.S.C. 101 additionally requires that the invention shall be useful. These requirements on the content of the claim would seem to compel an equal result in the reading of the claim. The claim may not be divested of its *essential* parts.

Those who would dismember the claim cite this Court's decision in *Parker* v. *Flook* as cause for such action. However, this Court simply pointed out that superfluous subject matter, *i.e.* matter which does not participate in the invention, can not serve to transform

an unpatentable principle into patentable subject matter, *Flook*, 437 U.S. at p. 590. This observation gives no one the right to read away an essential element of a claim.

The Court of Customs and Patent Appeals (CCPA) has so held in the case of *Diamond* v. *Bradley*, No. 79-885, to which this Court has granted certiorari (Mar. 17, 1980). The CCPA read the claim as a whole, including all the hardware elements belonging to the invention, and determined that the claim was for a machine. The CCPA also noted that Bradley's programed computations supported a machine function rather than a method of calculation. *In re Bradley*, 600 F.2d 807 (1979).

The Court of Claims gave petitioner's claims an entirely different kind of reading. The court reduced the claim to a single element, thereby depriving the claim of the very source of its directional information, which is the gyroscopically stabilized reference body. It then called the isolated element unpatentable and applied this conclusion to the whole claim without any further persuasion.

Irrespective of how the inventions of Bradley and petitioner individually qualify as patentable subject matter under 35 U.S.C. 101, their claims are entitled to be read under equal ground rules. Petitioner would like to see this case considered together with *Bradley*.

CONCLUSION

The petition should be granted.

Respectfully submitted.

George Arshal
Petitioner

APPENDIX 1

IN THE UNITED STATES COURT OF CLAIMS

No. 431-75

(Decided March 19, 1980)

GEORGE ARSHAL

v.

THE UNITED STATES

Before KASHIWA, KUNZIG, and BENNETT, *Judges*.

ON DEFENDANT'S MOTION AND PLAINTIFF'S CROSS MOTION FOR SUMMARY JUDGMENT

PER CURIAM: Plaintiff sues the United States for patent infringement, within our jurisdiction under 28 U.S.C. § 1498 (1976). The case is before us on plaintiff's exception to the recommended decision submitted by Trial Judge Browne under Rule 54(a). The trial judge concluded that plaintiff's patent was invalid under 35 U.S.C. § 101 (1976), but denied defendant's motion for patent invalidity under 35 U.S.C. § 103 (1976). He also held that if the patent had been valid, then defendant's actions amounted to infringement. Upon consideration of the briefs and the oral argument of the parties, we agree with the trial judge's conclusion of invalidity

under 35 U.S.C. § 101 and to this extent adopt his opinion and conclusion of law as the basis for our judgment in this case. Because of our holding of invalidity under 35 U.S.C. § 101, it is not necessary to render a determination of infringement. For the same reason, we also do not render a determination as to the correctness of the denial of defendant's motion for patent invalidity under 35 U.S.C. § 103. We have modified the trial judge's opinion, therefore, to delete all references to the 35 U.S.C. § 103 invalidity question and the infringement question. It is, thus, concluded that plaintiff is not entitled to recover, and the petition is dismissed.

The trial judge's report, modified as above indicated and also by certain minor additions and deletions, follows.

OPINION

BROWNE, *Trial Judge:* This action is brought by George Arshal (plaintiff) against the United States (defendant) under the provisions of 28 U.S.C. § 1498(a) for recovery of reasonable and entire compensation for the alleged use or manufacture by or for defendant of the invention covered by claims 2, 3, 6, and 7[1] of his United States Patent No. 3,319,052 (the '052 patent),

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[1] The text of the asserted claims is set forth in Appendix A, *infra*.

issued May 9, 1967, for a "Directional Computer." The application on which the patent is based was filed January 20, 1966 (Serial No. 533,106) as a continuation of a subsequently abandoned application (Serial No. 206,801) filed July 2, 1962.

Defendant moved for summary judgment on March 30, 1978, on the issue of validity, and plaintiff moved for summary judgment on April 7, 1978, on the issues of validity, infringement, and license. The court referred the motions to the trial judge on July 25, 1978, pursuant to Rule 54 for his opinion and recommendation for the conclusion of law.

Upon review of the motions, supporting briefs, and extensive oral arguments of both parties heard on February 7 and 8, 1979, we have concluded that the '052 patent is invalid; wherefore, plaintiff is not entitled to recover on his claim for reasonable and entire compensation. Accordingly, defendant's motion for summary judgment is granted and plaintiff's motion for summary judgment on the issue of validity is denied. Since holding the patent to be invalid makes moot the issues of infringement and license, these two issues are not considered. The holding of invalidity also being dispositive of the case, the petition is dismissed.

I. *The Pleadings*

Plaintiff filed his petition, *pro se*, on December 12, 1975, after having failed to negotiate an administrative

settlement of his claim with the Department of the Navy. In his petition, plaintiff alleges that claims 2, 3, 6, and 7 of his patent are infringed by the guidance system manufactured for and used by defendant in its Poseidon missile, and also by the guidance system intended for use in the Trident C4 (Trident) missile. Lockheed Missiles and Space Company, Inc., of Sunnyvale, California (Lockheed) is alleged to be the sole manufacturer of the missiles for the defendant.

Defendant filed its answer to the petition on April 9, 1976. In its answer defendant admitted that the Poseidon missiles were supplied by Lockheed and used by defendant, and that certain plans exist with respect to manufacture and use of the Trident C4 missile by defendant. Defendant denied, however, that the patent has been infringed or that it was duly and legally issued, or otherwise enforceable. Defendant contends that, in any event, it is licensed under the patent in suit.

II. *The Patent in Suit*

In order to comprehend the legal issues of this case, it is necessary first to have a basic understanding of the underlying mathematics of the invention, since it involves vectors, vector algebra, and vector calculus. A very brief discussion of these concepts is presented in Appendix B of this opinion. The discussion which follows presumes both a basic knowledge of elementary algebra and an understanding of the appended discussion of vector mathematics.

The '052 patent is entitled, "Directional Computer." It defines the invention as "a vectorial data processing system for extracting or prescribing directions and their rates of change from given input vectors." The patent specification specifically states that the output direction is affected by the input vector in one or both of the following two ways:

(1) So that the output direction rotates around the input vector to describe a conical surface,

(2) So that the output direction rotates directly towards the input vector and seeks coalignment.

The system is described as useful in aircraft flight control, as one example. It is also intended for use to "service demanding applications requiring wide ranging directional controls under a variety of options." The remaining portion of the specification describes the invention primarily in terms of vector algebra. The drawings illustrate examples of the relationship of the algebraic expressions disclosed in the specification in terms of circuit diagrams and other graphic symbols.

III. *Validity of the Claims Under 35 U.S.C. § 101*

A. *The Positions of the Parties*

Defendant has alleged in its motion for summary judgment that claims 2, 3, 6, and 7 of the patent are invalid because they are drawn to subject matter which

is not patentable under the Patent Act of 1952 (Title 35, United States Code). Specifically, defendant contends that the claims, essentially, are drawn to a mathematical equation, and that a mathematical equation is not patentable subject matter under 35 U.S.C. § 101.[2]

Claim 2 of the patent is illustrative of all of the claims in suit and states:[3]

2. A directional computer comprising

(a) a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity,

(b) means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and

(c) means to receive the said input signals and generate a plurality of output signals *expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said out-*

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2 35 U.S.C. § 101 states: "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."

3 The claim has been broken down into three parts for analytical purposes. It does not appear in this format in the patent.

> *put vector and the said input vector*, whereby the said output vector rotates around said input vector. [Emphasis added.]

To support its position that claim 2 is essentially directed to a mathematical equation, defendant points to the italicized phrase in part (c) of claim 2. (This language also appears in the remaining claims in suit, namely, claims 3, 6, and 7). Although plaintiff does not dispute that this language is the verbal equivalent of a mathematical expression,[4] plaintiff points out that this language forms only a portion of the claim and that, when considered in its entirety, the claim is not directed to an equation, but to a *machine*.

B. *The Applicable Law*

Since mathematical expressions or equations, *per se*, are not susceptible to patent protection under section 101 of the Patent Act,[5] we must determine whether or not the asserted claims define an invention which is

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[4] Specifically, the language recites the mathematical expression $\overline{b} = \int(\overline{b} X \overline{Y})\, dt$, where $\overline{Y}$ represents a desired input vector and $\overline{b}$ represents a directional output vector.

[5] Section 101 of the Patent Act, *see* fn. 2, *supra*, does not expressly *exclude* a mathematical expression or equation as patentable subject matter. Case law, however, has established that they are not included. *See e.g., Gottschalk v. Benson*, 409 U.S. 63, 175 USPQ 673 (1972); *Mackay Co. v. Radio Corp.*, 306 U.S. 86, 40 USPQ 199 (1938).

merely a mathematical expression or equation. If the mathematical expression or equation is simply an adjunct to the invention sought to be covered, the inclusion thereof in the claims is not fatal to their validity. If, however, the invention itself can be expressed only in terms of the mathematical expression or equation, it is outside the scope of 35 U.S.C. § 101 and, therefore, is invalid under the applicable case law.

Tests for determining whether a claim is directed to subject matter which is not patentable have been applied in some cases which predated the 1952 Patent Act, and many others subsequent to that Act. In some early cases, because the "point of novelty" or truly novel element in the claims was determined to be a mathematical expression or equation, the claims were held to be nonstatutory.[6] *See e.g., In re Abrams*, 188 F.2d 165, 89 USPQ 266 (CCPA 1951).

The "point of novelty" test was, at first, followed after the effective date of the 1952 Act, but was formally rejected by the Court of Customs and Patent Appeals (CCPA) in *In re Bernhart*,[7] 417 F.2d 1395, 163

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[6] The word "nonstatutory" is sometimes used to apply to a claim directed to subject matter which is not expressly entitled to patent protection.

[7] As a point of fact, the CCPA first rejected this approach in *In re Prater*, 415 F.2d 1378, 159 USPQ 583 (CCPA 1968). However, the opinion in *Prater* was subsequently vacated, 415 F.2d 1378, 160 USPQ 230, and replaced by an opinion which did not discuss the pro-

USPQ 611 (CCPA 1969).[8] In *Bernhart*, among the claims before that court was an apparatus claim directed to a general purpose computer programmed to calculate the results of a complex mathematical equation. In reversing the Examiner's rejection of this claim (which was based upon the Examiner's belief that the novelty of the claim lay in the equations with which the computer was programmed), the court stated:

> The principle [behind the Examiner's rejection] may, we think, be fairly stated as follows: If, in an invention defined by a claim, the novelty is indicated by an expression which does not itself fit in a statutory class (in this case not a machine or a part thereof), then the whole invention is nonstatutory since all else in the claim is old. We do not believe this view is correct under the Patent Act and the case law thus far developed. [*Id.* at 1399, 163 USPQ at 615-16.]

Instead, the court concluded that:

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priety of the "point of novelty" test, *see* 415 F.2d 1393, 162 USPQ 541 (CCPA 1969).

[8] The decisions of the Court of Customs and Patent Appeals, while being neither controlling nor binding on this court, are nevertheless accorded great weight and respect in view of the manifest expertise of that court in determining whether or not claims presented in pending applications for patents satisfy the requirements of the patent statutes.

> [I]f a machine is programmed in a certain new and unobvious way, it is physically different from the machine without that program; its memory elements are differently arranged. The fact that these physical changes are invisible to the eye should not tempt us to conclude that the machine has not been changed. If a new machine has not been invented, certainly a "new and useful improvement" of the unprogrammed machine has been, and Congress has said in 35 U.S.C. § 101 that such improvements are statutory subject matter for a patent. [*Id.* at 1400, 163 USPQ at 616.]

The CCPA reaffirmed its rejection of the "point of novelty" test in *In re Musgrave*, 431 F.2d 882, 167 USPQ 280 (CCPQ 1970), and pointed out the fallacy in that test:

> [I]t is our view that [the point of novelty test is] logically unsound. According to [this test], a process containing both "physical steps" [the statutory portion] and so-called "mental steps" [the non-statutory portion] constitutes statutory subject matter if the "alleged novelty or advance in the art resides in" steps deemed to be "physical" and non-statutory if it resides in steps deemed to be "mental". It should be apparent, however, that novelty and advancement of an art are irrelevant to a determination of whether the nature of a process is such that it is encompassed by the meaning of

> "process" in 35 U.S.C. § 101. Were that not so, as it would not be if [the point of novelty test] were the law, a given process including both "physical" and "mental" steps could be statutory during the infancy of the field of technology to which it pertained, when the physical steps were new, and non-statutory at some later time after the physical steps became old, acquiring prior art status, which would be an absurd result. Logically, the identical process cannot be first within and later without the categories of statutory subject matter, depending on such extraneous factors. [*Id.* at 889, 167 USPQ at 286-87.]

Instead, the court stated that all that was needed to make the claimed process statutory under 35 U.S.C. § 101 was "that it be in the technological arts so as to be in consonance with the Constitutional purpose to promote the progress of 'useful arts'." 431 F.2d at 893, 167 USPQ at 289-90. Finding the claims at issue to be within the technological arts, the court reversed the Examiner's rejection.

The new "technological arts" test was reaffirmed by the CCPA in *In re Foster*, 438 F.2d 1011, 169 USPQ 99 (CCPA 1971), as it stated that "it is not important whether the claims contain mental steps [the non-statutory portion] or not if the process is within the technological arts." *Id.* at 1015, 169 USPQ at 101. And in *In re Waldbaum*, 457 F.2d 997, 173 USPQ 430 (CCPA 1972), *aff'd*, 559 F.2d 611, 194 USPQ 465 (CCPA 1977),

the CCPA explained that "[t]he phrase 'technological arts', as we have used it, is synonymous with the phrase 'useful arts' as it appears in Article I, Section 8 of the Constitution." *Id.* at 1003, 173 USPQ at 434.

In *In re Benson*, 441 F.2d 682, 169 USPQ 548 (CCPA 1971), the CCPA again applied their "technological arts" test to reverse a section 101 rejection of a claim drawn to a method of converting one form of numerical representation into another, utilizing a novel algorithm. After concluding that the process had no practical use except in connection with a digital computer, the court stated:

> It seems beyond question that the machines - the computers - are in the technological field, are a part of one of our best-known technologies, and are in the "useful arts" rather than the "liberal arts" as are all other types of "business machines," regardless of the uses to which their users may put them. How can it be said that a process having no practical value other than enhancing the internal operation of those machines is not likewise in the technological or useful arts? We conclude that the Patent Office has put forth no sound reason why the claims in this case should be held to be nonstatutory. [*Id.* at 688, 169 USPQ at 553.]

Certiorari was granted in *Benson*, and the Supreme Court, however, *reversed*. *Gottschalk* v. *Benson*, 409

U.S. 63, 175 USPQ 673 (1972).[9] The Supreme Court began by pointing out that the case law has well established the principle that one may not patent an *idea*. Directing its attention to the *claims* at issue, the Court found two fatal objections to their validity: first, that "the claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use", *id.* at 64, 175 USPQ at 674, but were "so abstract and sweeping as to cover both known and unknown uses" of the *claimed* invention, *id.* at 68, 175 USPQ 675; and second, that because the mathematical formula embodied in the *claims* had "no substantial practical application except in connection with a digital computer, * * * the patent [claims] would wholly pre-empt the mathematical formula and in practical effect would be a patent on the algorithm itself." *Id.* at 71-72, 175 USPQ at 676.

The determination of whether a *claim* preempts nonstatutory subject matter under the rationale of *Benson* has been determined to require a two-step analysis:

> First, it must be determined whether the claim directly or indirectly recites an "algorithm" in the *Benson* sense of that term, for a claim which fails even to recite an algorithm clearly cannot wholly preempt an algorithm. Second, the claim must be

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[9] All subsequent references to "*Benson*" are to *Gottschalk v. Benson*, 409 U. S. 63, 175 USPQ 673 (1972).

> further analyzed to ascertain whether in its entirety it wholly preempts that algorithm. [*In re Freeman*, 573 F.2d 1237, 1245, 197 USPQ 464, 471 (CCPA 1978)].

We now direct our attention to that analysis.

Plaintiff contends that his claims do not recite an "algorithm" in the *Benson* sense, but are directed to "physical geometry." Specifically, plaintiff states that his claims are distinguishable from those in *Benson* because his are "concerned with creating a circumstance," while those in *Benson* are concerned with "determining the value of a variable that already exists in the context of a specific set of circumstances." We find, however, this distinction, if it is one at all, to be of no consequence. The important point is that the claims both in *Benson* and in this suit are directed to a particular means for transforming defined input signals into useful output signals. Although *Benson* did not render all algorithms (as defined by the dictionary) to be nonstatutory, subsequent case law has clearly established that a formula or equation, even if expressed in its prose equivalent, is the type of subject matter to which the *Benson* rationale must be applied. *See In re Freeman*, 573 F.2d at 1246, 197 USPQ at 471 (and cases cited therein).

Plaintiff further argues that *Benson* is inapplicable because the claims in *Benson* are drafted in the form of a "method," whereas the claims in this suit are drafted

in the form of an "apparatus" (using "means plus function" language).[10] However, even the language used in *Benson* itself indicates that the fundamental principles governing the statutory determination of "method" claims is equally applicable to "apparatus" claims:

> As we stated in *Funk Bros. Seed Co. v. Kalo Co.*, "He who discovers a hitherto unknown phenomenon of nature has no claim to a monopoly of it which the law recognizes. If there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end." *We dealt there with a "product" claim, while the present case deals with a "process" claim. But we think the same principle applies.* [409 U.S. at 67-68, 175 USPQ at 675 (citations omitted and emphasis added)].

As the CCPA stated in *In re Freeman*, it is not the form of the claim which is controlling but its substance:

> Though a claim expressed in "means for" (functional) terms is said to be an apparatus claim, the subject matter as a whole of that claim may be indistinguishable from that of a method claim drawn to

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[10] It should be noted that plaintiff, who prosecuted his patent application *pro se*, did not have the benefit of the courts' decisions rendered after May 9, 1967, since the patent issued on that date was based on his application which was first filed in 1962 and refiled in 1966. *In re Abrams, supra*, was the only significant precedent available during the pendency of plaintiff's applications.

> the steps performed by the "means" * * *. [I]f allowance of a method claim is proscribed by *Benson*, it would be anomalous to grant a claim to apparatus encompassing any and every "means for" practicing that very method. [573 F.2d at 1247, 197 USPQ at 472 (footnote omitted)].

To do otherwise would make the determination of patentable subject matter depend simply on the draftman's skill which would ill serve the principles underlying the prohibition against patents for ideas. *See Parker v. Flook*, 437 U.S. 584, 593, 198 USPQ 193, 198 (1978).

Plaintiff finally urges that *Benson* is inapplicable because *Benson* dealt with an algorithm used only in digital computers, whereas plaintiff's patent discloses his equation for use in analog computers. While it is true that the Supreme Court in *Benson* expressly declined to extend its holding to algorithms used in analog computers, [11] it is also true that they did not in any way disapprove of such an extension. As we can see no factual reason for making such a legal distinction, we believe that the rationale of *Benson* is equally applicable to algorithms used in analog computers. This

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[11] Specifically, the Court stated: "It is said that we have before us a program for a digital computer but extend our holding to programs for analog computers. We have, however, made clear from the start that we deal with a program only for digital computers." 409 U.S. at 71, 175 USPQ at 676.

conclusion, however, is unnecessary to our decision as the claims in suit are in no way limited to analog computers. That the specification may disclose analog computers in one embodiment of the claimed invention is irrelevant. Although the specification may be properly used to *interpret* limitations already present in the claims, *Westwood Chemicals, Inc. v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), the specification may never be used to *add* additional and otherwise nonexistent limitations to those claims, *Siegel v. Watson*, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). To be sure, not even plaintiff seriously contends that his claims do not encompass digital computers for plaintiff, himself, contends that defendant's alleged infringing computer, which is a digital computer, is fully encompassed by his patent claims. It is a fundamental principle of patent law that a claim may not be narrowly construed to avoid invalidity and then broadly construed to encompass the accused device. *See e.g.*, *Dominion Magnesium Ltd. v. United States*, 162 Ct. Cl. 240, 320 F.2d 388, 138 USPQ 306 (1963).

Accordingly, the rationale of *Benson* is applicable to a determination of validity of the claims in this case. The issue to which we now direct our attention is whether, under the rationale of *Benson*, these claims "wholly pre-empt the mathematical formula" which they incorporate.

C. *Application of the Law to the Claims*

1. *Claim 2*[12]

Claim 2 recites three elements which can, functionally, be summarized as follows:

(a) a physically defined, stabilized reference frame[13]

(b) means of obtaining input signals defining an input vector in relation to the stabilized reference frame; and

(c) means to calculate $\overline{b} = \int (\overline{b} \times \overline{Y})\, dt$,

where $\overline{Y}$ is the input vector, $\overline{b}$ is the output vector, and the integration is relative to the stabilized reference frame.[14]

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12 For the full text of claim 2, see Appendix A, *infra*.

13 This element is further described in the claim as "having means of sensing and suppressing its angular velocity." However, it is clear from the specification that this language merely clarifies the essential nature of a "stabilized reference frame" and thus is without limiting effect. *See* col. 5, lines 4-9. To be sure, plaintiff wholly agrees with this conclusion.

14 This element is further described in the claim by the language "whereby the said output vector rotates around the said input vector." However, this language has no limiting effect for it is clear that in every implementation of the claimed equation the "output vector rotates around the said input vector" whether it rotates to trace a conical surface around the input vector or seeks coalignment with it.

The statement that "the integration is relative to the stabilized reference frame" is used to mean what the

The Supreme Court has indicated in *Benson* that a claim should be "limited to [a] particular art or technology, to [a] particular apparatus or machinery, [and] to [a] particular end use." 409 U.S. at 64, 175 USPQ at 674. If we consider only element (c) of claim 2 for the moment, it is clear that it violates each and every requirement of this rule. First, it in no way specifies any use for the calculated output vector and, therefore, is not "limited to any particular end use." Second, the "means plus function" language encompasses any and every type of apparatus or machine which could be used to implement the claimed equation and, therefore, the element is not "limited to any particular apparatus or machinery." Finally, the element has application in arts or technologies as diverse as the equation itself and, therefore, is not "limited to any particular art or technology." The element truly does, in the *Benson* sense, wholly preempt the mathematical formula which it embodies.

Of course, claim 2 recites more than merely element (c). However, the effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*. The reason for this conclusion

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inventor in his specifications has defined it to mean, namely that the vector quantities of the integrand, *i.e.*, $\overline{b}$ and $\overline{Y}$ are expressed in reference to the stabilized reference frame. *See* cols. 4 and 5, lines 64-75 and 1-4, respectively.

becomes clear upon an understanding of the purpose of these elements.

As we have stated above, element (c) merely calls for means to perform a mathematical computation which, by itself, is unpatentable subject matter. Because the equation recited in element (c) is a calculation using an input vector, *i.e.*, $\overline{Y}$, apparatus performing that calculation necessarily requires means to generate the value of the input vector, $\overline{Y}$. Element (b) is for just that purpose and, therefore, is essential to the performance of the computation. Thus, the "limitation" in the claim effectuated by the addition of element (b) is, for all practical purposes, not a limitation at all because element (c) cannot function in the absence of element (b). Of course, if element (b) recited apparatus which generated a *particular* type of input signal, such as a specified physical quantity, our conclusion might be different. But it does not, and, in fact, it states that the input signals defining the input vector may be representative of "any desired value."

The same is true of element (a). Because the equation claimed in element (c) operates exclusively on vectors, as we have point out in our background mathematics discussion, Appendix B, *infra*, all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation.[15] This is the

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[15] Plaintiff wholly agrees with this statement.

purpose of element (a) and it too, therefore, is essential to the performance of the computation claimed in element (c). While it is true that element (a) is limited to a particular type of reference frame, *i.e.*, a "physically defined, stabilized reference frame," the very nature of the claimed equation requires this specific type of reference frame to produce a meaningful result.[16]

In *In re Christenson*, 478 F.2d 1392, 178 USPQ 35 (CCPA 1973), the CCPA was presented with a similar case. The claim at issue contained a mathematical equation and several "data gathering" steps. In rejecting the contention that the addition of "data gathering" steps could convert a nonstatutory claim into statutory subject matter, the court said:

> Given that the *method of solving* a mathematical equation may not be the subject of patent protection, it follows that the addition of the old and necessary antecendent *steps of establishing values*

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[16] The claimed equation, $\overline{b} = \int \overline{b} \times \overline{Y}\, dt$, is but one embodiment of the more general equation

$$\overline{b} = \int ((A/b^2 - B)\overline{b} + \overline{b} \times \overline{Y} + \overline{b} \times \overline{w})\, dt,$$

(*see* col. 4, equation (17)) with $A/b^2 - B = \overline{w} = 0$ by definition. To make $\overline{w}=0$, however, *requires* a "physically defined, stabilized reference frame." *See* col. 5, lines 1-7. Thus, the claimed equation cannot be meaningfully implemented with any other type of reference frame. *Accord, see* plaintiff's submission to standard pretrial order on liability (PSPOL), ¶ 23, 24 (filed February 27, 1978).

> *for the variables in the equation* cannot convert the unpatentable method to patentable subject matter. [*Id.*, at 1394, 178 USPQ at 37-38 (emphasis supplied)].

The rationale behind this pronouncement of law was later explained by Chief Judge Markey in *In re Sarkar*, 588 F.2d 1330, 200 USPQ 132 (CCPA 1978):

> No mathematical equation can be used, as a practical matter, without establishing and substituting values for the variables expressed therein. Substitution of values dictated by the formula has thus been viewed as a form of mathematical step. If the steps of gathering and substituting values were alone sufficient, every mathematical equation, formula, or algorithm having any practical use would be per se subject to patenting as a "process" under § 101. [Id., at 1335, 200 USPQ at 139.]

Even where the antecendent "data gathering" steps are novel and unobvious, their recitation in combination with a mathematical computing step is legally insufficient to give rise to a patentable claim under § 101 of the Patent Act. *In re Richmann*, 563 F.2d 1026, 195 USPQ 340 (CCPA 1977); *accord*, *In re Sarkar*, *supra* at 1336 n. 18, 200 USPQ at 139 n. 18.

Of course, these CCPA precedents dealt with claimed *processes*, not *apparatus*. However, as we have already pointed out, the controlling principles are the same. Otherwise, the anomaly might result that a

claim to apparatus encompassing any and every means for performing a method might be valid while, at the same time, a claim encompassing all methods of obtaining the desired result might be proscribed by *Benson*. *In re Freeman*, 573 F.2d at 1247, 197 USPQ at 472.

Plaintiff maintains, however, that claim 2 does not preempt a mathematical equation because the preamble "[a] directional computer" adequately limits the scope of the claim to a particular technology, *i.e.*, the directional computer technology. We find as a matter of law, however, that those words do not effectively limit the claim to any *particular* technology.[17]

First of all, computers are applicable to all technologies, not to any *particular* technology. Although the type of computer is specified as a "directional" computer, in the present case, this is a limitation without substance because vector computations (the type of computation recited in the claim), by definition, include directional computations. Thus, the claimed mathematical formula already intrinsically calls for directional computations and, therefore, use of the word "directional" in the preamble creates no additional limitation.

Second, there is a substantial question whether

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[17] While the specification describes the invention as being a "vectorial data processing system" which is useful in "aircraft flight control," all of the claims are directed to a "directional computer," without recitation or limitation as to *any* field of use.

words in a preamble which do not appear in the body of the claim may even properly be used to limit the scope of the claim. *See e.g., Strador v. Watson*, 244 F.2d 737, 113 USPQ 365 (D.C. Cir. 1957). Where, as here, the effect of the words is at best ambiguous (*i.e.*, as pointed out above, there is uncertainty whether the words have any limiting effect on the scope of the claim), a compelling reason must exist before the language can be given weight. *Cf. In re de Castelet*, 562 F.2d 1236, 1244, n. 6, 195 USPQ 439, 447, n. 6 (CCPA 1977) (Where there is a potential for misconstruction of preamble language, a compelling reason must exist before the language can be given weight.) We can see no such reason in this case, for the language in the body of claim 2, standing alone, is clear and unambiguous.

Even assuming, *arguendo*, that the preamble language "[a] directional computer" does have the effect of limiting the scope of claim 2 to a particular technology, the fact remains that claim 2 still preempts a mathematical equation, albeit in a limited and specific application. As the CCPA established in *In re Waldbaum*, 559 F.2d 611, 194 USPQ 465 (CCPA 1977), preemption of a mathematical calculation is fatal to the validity of a claim regardless of the scope of that preemption:

> [C]laims 1, 2 and 19 do not represent "no less of a 'computer processing program' than did claim 8 in *Benson*," because they are limited to the specific application of calculating the number of busy and

> idle lines in a telephone system. They would not preempt all uses of the algorithm [citing uses of the algorithm outside of the claimed invention], but would preempt only use of the algorithm in calculating the number of busy and idle lines in a telephone system. At the same time, it must be recognized that a patent on these claims would, in practical effect, be a patent on the algorithm itself - albeit in its limited, specific application to *calculating* the number of busy and idle lines in a telephone system.* * *
>
> In view of the foregoing, we hold that claims 1, 2 and 19 do not define a statutory process within the meaning of 35 USC §§ 100 and 101. [*Id.* at 617, 194 USPQ at 469-70 (footnotes omitted).

Similarly, the Supreme Court recently held in *Parker* v. *Flook*, 437 U.S. 584, 595 n. 18, 198 USPQ 193, 199 n. 18 (1978), that "a claim for an improved method of calculation, even when tied to a specific end use, is unpatentable subject matter under § 101."

It is important to point out that a claim is not invalid merely because it recites a mathematical equation or computation. *Parker* v. *Flook*, *supra*. Rather, a claim reciting a mathematical equation or computation as one of its elements will be invalid only if, when considered in its entirety, the essence of the claim is nothing more than that element. Although the line of demarcation between a patentable and an unpatentable (or non-patentable) claim does not always shimmer with

clarity, a persuasive index of a valid mathematical-calculating type of claim is when the claimed computation or equation is used not merely to calculate a numerical value, but is used to effectuate a physical result. For example, the CCPA recently held a series of claims directed to methods for removing unwanted noise from seismic data not to be invalid under § 101 because the purpose of the claimed invention was to "filter out extraneous and erroneous components and to physically record a noiseless seismic trace on a record medium," rather than to merely "compute a new value." *In re Johnson*, 589 F.2d 1070, 200 USPQ 199 (CCPA 1978). As is apparent from a reading of claim 2 of the patent in suit, however, the sole purpose of the invention recited therein is merely to "compute a new value." Thus, for this reason and all of the reasons discussed above, we conclude that, under the rationale of *Benson* and its progeny, unlike the claims in *Johnson*, claim 2 is invalid.

2. *Claim 6*[18]

We find the additional language placed in the remaining claims in suit insufficient to distinguish them from nonstatutory claim 2, as a matter of law. With respect to claim 6, the parties agree that it differs from claim 2 in that it calls for the following additional

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[18] The full text of claim 6 is recited in the Appendix A, *infra*.

elements:

(d) a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween,

(e) the input signals being referred to the second reference frame to express an input vector, and

(f) the "means" receiving the input signals and generating the output signals to include the coordinate transformation means in (d) above.

See PRDRFA at ¶ 21. The essential difference between claim 6 and nonstatutory claim 2, therefore, is that claim 6 calls for an *additional* data gathering element, the "second reference frame," and for an additional mathematical calculating element, the "means to perform a coordinate transformation."[19] Certainly, the addition of a second mathematical calculating element (an element which is on its face nonstatutory), cannot change a nonstatutory claim into one which is statutory; and we think that, given the principle that the addition of a "data gathering" element cannot change an otherwise nonstatutory claim into a statutory claim, the inclusion of an *additional* "data gathering" element in the claim will also not have

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[19] The specifications disclose that the "means to perform a coordinate transformation" is merely apparatus which performs a series of known mathematical computations. *See* cols. 6 and 7, lines 15-17 and 1-3, respectively.

that effect. Accordingly, we conclude that claim 6 does not define an invention which is entitled to patent protection under 35 U.S.C. § 101. We now consider the effect of the differences between claim 3 and claim 2.

3. *Claim 3*[20]

When the value of the output vector, $\overline{b}$, recited in claim 2 is computed, as we have explained in the mathematical background discussion, *infra* at Appendix B, what is actually computed is the scalar values of the output vector's three projections on the axes of a cartesian coordinate reference frame, *i.e.*, b_1, b_2, and b_3. Thus, while claim 2 recites only a single mathematical equation, *i.e.*, $\overline{b} = \int (\overline{b} \times \overline{Y})\, dt$, the solution of that equation requires the following three separate computations (a fact not disputed by the parties:[21]

$$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt;$$

$$b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt; \text{ and}$$

$$b_3 = \int (b_1 Y_2 - b_2 Y_1)\, dt.$$

Claim 3, on the other hand, expressly limits its scope by defining only the third axis projection (Y_3) with respect to the reference frame. Unlike claim 2,

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[20] The full text of claim 3 is presented in Appendix A, *infra*.

[21] The derivation of these equations is shown in the background mathematics discussion, *infra* at Appendix B.

the remaining projections of the input vector (*i.e.*, Y_2 and Y_1) are not expressly defined. Also, unlike claim 2, only *two* of the projections of the output vector are calculated (b_1 and b_2),[22] rather than the full set (b_1, b_2, and b_3) calculated by the apparatus recited in claim 2. Based upon this analysis (the accuracy of which is not disputed), the only difference between claim 3 and claim 2 is that claim 3 calls for apparatus which performs only *two* computations, while claim 2 intrinsically calls for apparatus which performs *three* computations. This difference, however, does not make claim 3 any less "abstract" or "sweeping" in the *Benson*

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[22] The parties dispute the implication to be drawn from the failure of the claim to expressly define the value of two of the three projections of the input vector (*i.e.*, Y_2 and Y_1). Plaintiff contends that the inference to be drawn is that they may be of any value. Thus, plaintiff contends, the two claimed computations are

$$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt \text{ and}$$
$$b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt$$

which are identical to two of the three computations claimed in claim 2. Defendant contends that the only proper interpretation of claim 3 is that the two unnamed projections (Y_2 and Y_3) must be consistently zero. Thus, defendant contends, the two claimed computations are

$$b_1 = \int (b_2 Y_3)dt \text{ and } b_2 = \int (-b_1 Y_3)\, dt$$

which are *not* identical to any of the three computations claimed in claim 2. However, the resolution of this dispute is irrelevant to the issue of claim validity under § 101 because, regardless of which interpretation is correct, the fact remains that a computation has been claimed.

sense than claim 2. It merely alters the quantity and perhaps the substance[23] of the computations claimed, not the fact that a computation has been claimed. We conclude, therefore, that claim 3 is also invalid under the rationale of *Benson*.

4. *Claim 7*[24]

Claim 7 is identical to claim 6, except that it incorporates the language which distinguished claim 3 from claim 2. In other words, claim 7 is identical to claim 6, except that it calls for only *two* computations as opposed to the *three* computations called for by claim 6. Accordingly, for the same reasons given above for finding claim 3 nonstatutory, claim 7 is also directed to nonstatutory subject matter.

In summary, we have concluded that all of the claims in suit are invalid under the rationale of *Benson* and its progeny, because they preempt the mathematical formulae which they embody and, in practical effect, claim the mathematical formula itself. This conclusion, we think, is fortified by plaintiff's own admission that his invention is disclosed in a certain report, but that this report does not disclose *any* hardware or structure, *only mathematical equations*. *See* PRDRA at ¶ 17.

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[23] *See* n. 22, *supra*.

[24] The full text of claim 7 is presented in Appendix A, *infra*.

IV. *Summary and Conclusion*

While most courts are reluctant to grant summary judgment in patent cases involving technically sophisticated subject matter, *see e.g., Xerox Corp. v. Dennison Manufacturing Co.*, 332 F. Supp. 963, 966-67, 168 USPQ 700, 703 (S.D.N.Y. 1971), it is well established that summary judgment is permissible when the court can understand the relevant technology without the aid of expert opinion, *see e.g., Grayson v. McGowan*, 543 F.2d 79, 192 USPQ 571 (9th Cir. 1976). In the present case, the voluminous body of instructional materials offered in evidence by both parties, the helpful comments offered at the extensive and thorough oral hearing on the motions have enabled the court to sufficiently comprehend the subject technology to render a technically sound decision without hearing the testimony of technical expert witnesses.

Our analysis of the claims in suit and the accused structures has led us to conclude that all of the claims in suit fail to define an invention which is susceptible to patenting under 35 U.S.C., § 101 and are, therefore, invalid. In view of this finding, we have decided that it is unnecessary to rule on plaintiff's motion for summary judgment on the license and infringement issues, or other issues raised by either party.

For the reasons set forth herein, defendant's motion for summary judgment on the dispositive issue of invalidity is allowed, and plaintiff's motion for summary

judgment on the issue of validity is denied. The petition is dismissed.

APPENDIX A

The asserted claims of the '052 patent read as follows:

2. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and means to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

3. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, the axes of said reference frame being denoted by the numerals 1, 2, 3, means of obtaining an input signal in representation of any desired value, said input signal being referred to said axis 3 to express an input vector, and means to receive the said input signal and generate a pair of output signals expressing an output vector in

reference to the said axes 1 and 2 as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector is driven by the said input signal to rotate around the said axis 3.

6. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signals and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

7. A directional computer comprising a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity, a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween, means of obtaining an input signal in representation of any desired value, said input

signal being referred to an axis of said second reference frame to express an input vector, and means, including said coordinate transformation means, to receive the said input signal and generate a plurality of output signals expressing an output vector in relation to said stabilized reference frame as the integral of the cross product vector between the said output vector and the said input vector, whereby the said output vector rotates around the said input vector.

APPENDIX B

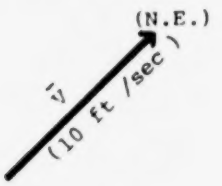
A. *Vectors*

Vectors are commonly used to describe certain physical quantities which require a statement of direction, as well as magnitude, to adequately specify the physical quantity. The velocity of a particle is one example of such a type of physical quantity. Although it would not be improper to specify the *magnitude* of the velocity alone (*e.g.*, 10 ft/sec), a full description of the vector quantity would require a statement of its *direction* as well (*e.g.*, N.E.). Physical quantities which require only a specification of magnitude to fully specify the physical quantity are known as scalars. Common examples of these are temperature, humidity, and time. When a vector is represented by a mathematical symbol, a horizontal line is drawn over that symbol to indicate that it is representative of a vector

quantity so that it may be distinguished from a scalar quantity. Thus the variable "V" is understood to be representative of a *scalar* quantity, while the variable "$\bar{V}$" is understood to be representative of a *vector* quantity.

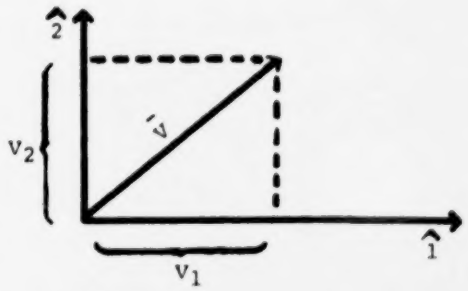
The specification of a vector quantity is always dependent on the frame of reference of its observer. For example, the velocity of a ball rolling on the floor of a moving train may appear to be relatively slow when viewed by a passenger seated on that train, but would appear to be relatively fast when viewed by an observer stationed on the ground near the train tracks. Thus, the specification of a vector quantity must always include a specification of the frame of reference with respect to which the vector has been expressed. Otherwise, the expression would be meaningless.

A vector may be graphically illustrated by an arrow having a length proportional to the magnitude of the vector and pointing in the direction specified by the vector. Thus, for the velocity vector example given above, the vector (labeled for convenience as $\bar{V}$) may be graphically illustrated as follows:



It is frequently useful to specify the vector, not in terms of its magnitude and direction, but in terms of its

"projections" on the perpendicular axes of a special type of reference frame called a cartesian coordinate reference frame. Graphically, this may be represented as follows:



With the perpendicular axes of the cartesian coordinate reference frame defined as axes $\overline{1}$ and $\overline{2}$, the projection of the velocity vector, $\overline{V}$, on the $\overline{1}$ axis would be the scalar quantity V_1, while the projection of the velocity vector, $\overline{V}$, on the $\overline{2}$ axis would be the scalar quantity V_2.

The representation of a vector can be extended into three spatial dimensions. This would simply require the addition of a third axis, $\overline{3}$, which would be normal (perpendicular) to the plane defined by axes $\overline{1}$ and $\overline{2}$, and a projection of the vector, $\overline{V}$, on that third axis to define the scalar quantity V_3. Therefore, when using a cartesian coordinate reference frame, a vector can be completely specified by reference to its three projections on the axes of that reference frame, *i.e.*, the scalar quantities V_1, V_2, and V_3. These quantities are also known as the "cartesian coordinates" of the vector.

B. *Vector Algebra*

Vectors are subject to many types of mathematical

operations. One such operation which is important to an understanding of this case is the "cross product." The cross product between two given vectors, *e.g.*, $\bar{A}$ and $\bar{B}$, always results in a third vector, *e.g.*, $\bar{C}$, and is mathematically written as: $\bar{C} = \bar{A} \times \bar{B}$. The symbol "X" denotes "cross product" and is not to be confused with the use of that symbol to indicate mere multiplication of A and B. When the vectors are expressed by their cartesian coordinates (*i.e.*, $\bar{A} = A_1, A_2, A_3$; $\bar{B} = B_1, B_2, B_3$; $\bar{C} = C_1, C_2, C_3$), the result of the cross product between vectors $\bar{A}$ and $\bar{B}$, *i.e.*, C_1, C_2, C_3, is defined by the following equations:

$$C_1 = A_2B_3 - A_3B_2;$$

$$C_2 = A_3B_1 - A_1B_3; \text{ and}$$

$$C_3 = A_1B_2 - A_2B_1.$$

Often a vector is expressed with respect to one frame of reference, but it is desirable to know its expression with respect to still another frame of reference. There is another mathematical operation called "coordinate transformation," which can be used to calculate this needed information. However, unlike the cross product, it is unnecessary to describe the mechanics of this computation.

For the purposes of this opinion, it is most important to understand that when the value of a vector expressed by three cartesian coordinates is calculated, the actual calculation requires three separate compu-

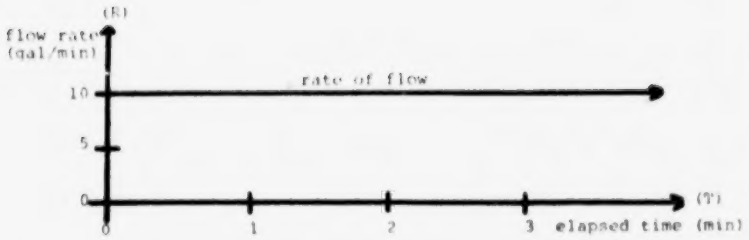
tations; *viz.*, one calculation for determining the value of each of the three cartesian coordinates. Thus, although a vector equation may appear to require only a single calculation for its solution, the calculation in fact requires three separate computations when the result is expressed in cartesian coordinates.

C. *Vector Calculus*

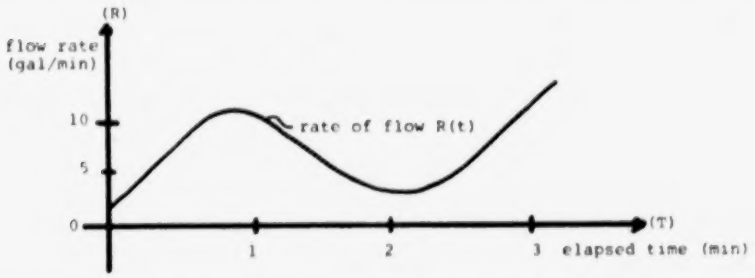
Another type of mathematical operation to which a vector may be subjected is integration. Integration is a mathematical operation unique to calculus and is denoted by the mathematical symbol "$\int$." Although the integration operation is very difficult to appreciate conceptually, it may nevertheless be intuitively understood by considering one of the types of problems which it was designed to solve.

Suppose one knew the rate of flow of water (R) coming out of a hose and wanted to know the volume of water (V) expelled after the passage of a certain period of time (T). The answer would be easily calculated by using the well-known equation: volume (V) = rate of flow (R) multiplied by the elapsed time (T) or V = RT. For example, if the rate of flow, R, is 10 gallons per minute (*i.e.*, R=10 gal/min), after the passage of 2 minutes (*i.e.*, T=2 min), 20 gallons of water would have been expelled (*i.e.*, RT = V).

Graphically, the rate of flow, R, may be illustrated as follows:



Suppose, instead, that the water pressure was erratic and thus caused the *rate* of flow, R, to vary from time to time. For example, suppose the rate of flow, R, followed the "profile" shown in the following graph:

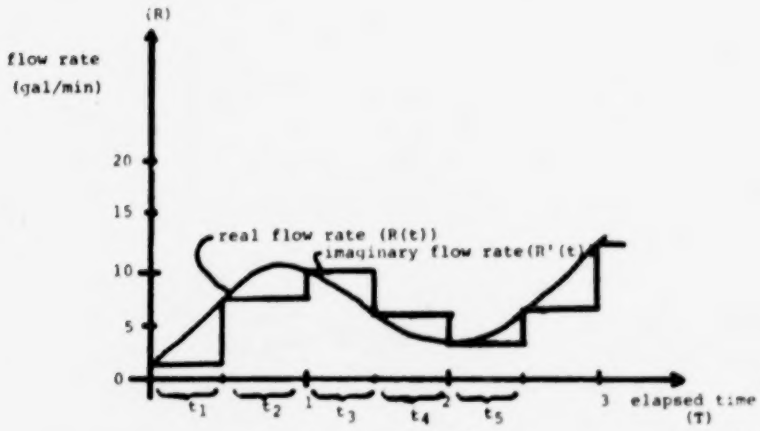


On the graph, the rate of flow, R, has been indicated as "R(t)", rather than merely "R," to indicate that the rate is no longer constant, but varies as a function of time (the addition of "(t)" to a variable name to indicate that it varies as a function of time (t) is standard mathematical nomenclature). Now, the computation of the volume of water expelled, V(t), after the passage of a known period of time is not so easily calculated for the equation V = RT is not applicable when the rate of flow does not remain *constant* during the given time interval.

Nevertheless, the volume of water expelled, V(t), after the passage of 2 minutes, can be *approximated* by calculating the volume of water expelled by an imagi-

nary water hose whose rate of flow profile, R'(t) (the apostrophe is used after the symbol "R" to distinguish the imaginary variables from the actual ones), is chosen to closely approximate the actual rate of flow profile, R(t), but has a shape susceptible to the application of the equation, V = RT.

One such imaginary rate of flow profile, R'(t), may be created by sampling the real rate of flow profile, R(t), every half-minute and by maintaining the value of the imaginary rate of flow profile between samples equal to the value of the last rate of flow. Graphically this would appear:



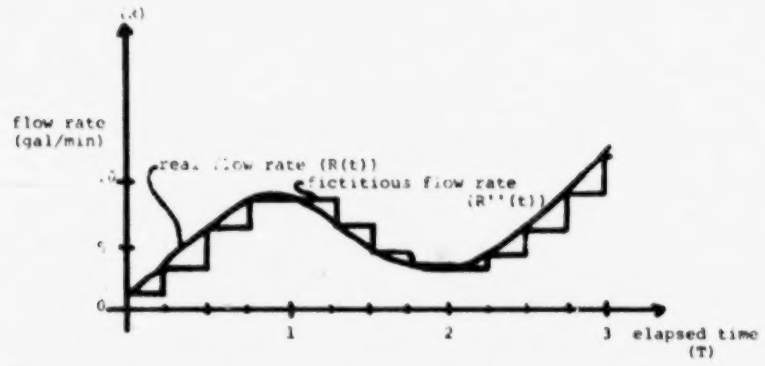
Although the imaginary rate of flow, R'(t), does not remain constant during the entire 2 minute time interval, it does remain constant during each half-minute time interval (designated as t_1, t_2, t_3, and t_4). Thus, the volume of water expended by the imaginary water hose, V'(t), during *each* half-minute segment would simply be the imaginary rate of flow during that time

segment, $R'(t_1)$, $R'(t_2)$, $R'(t_3)$, and $R'(t_4)$, times its respective flow time, t_1, t_2, t_3, and t_4, which in each case is one-half a minute. Mathematically, therefore, the total imaginary volume of water expended after two minutes, V'(2 min), would be:

$$\begin{aligned} V'(2\ \text{min}) &= V'(t_1) + V'(t_2) + V'(t_3) + V'(t_4) \\ &= R'(t_1)1/2 + R'(t_2)1/2 + R'(t_3)1/2 + R'(t_4)1/2 \\ &\simeq V(2\ \text{min}) \end{aligned}$$

("≃" means approximately equals.)

The error in the approximation of V(t) by equating it to V'(t) is directly related to the amount of difference between the two profiles. This difference can be minimized by increasing the frequency of samples in the imaginary rate of flow profile, R'(t). Thus, the following imaginary rate of flow profile, samples R"(t), which has twice as many samples per period of time as does R'(t), will yield an even more accurate approximation of V(t) than will V'(t):



As the density of the samples increases to infinity, R"(t) will become identical to R(t) and the accuracy of

the approximation for V(t) based on a calculation of V"(t) will approach theoretical perfection. At the limit when the density of samples does reach infinity, the calculation process is defined as *integration* and is denoted by the following equation (for this particular problem):

$$V(t) = \int R(t)dt$$

where "dt" signifies an infinitesimal length of time.

Essentially, therefore, integration is a method to calculate *and* sum an infinite series of mathematical computations. However, because of the infinitesimal (microfinite) nature of the time which passes between calculations, integration is known as a "continuous" method of computation, while the sample method described above, because it involves the calculation of a series of time-separated computations, is known as an individual or "discrete" method of calculation.

Devices called "analog integrators" can actually perform an integration operation on electronic signals. There are also mechanical devices which can integrate. An example of a mechanical device which can actually perform the integration operation required to precisely calculate V(t) in the given example is, quite simply, a large bucket! If the water expelled from the hose is channeled into the large bucket, no matter how the rate of flow, R(t), varies with time, the integrator, *i.e.*, the large bucket, will "keep track" of V(t) precisely. One need merely measure the volume of water in the large

bucket at the desired time to ascertain the value of V(t). This example of an integrator serves to intuitively illustrate the fundamental difference between an integrator which "continuously calculates" and the sample method which performs "discrete computations."

When a vector, expressed in terms of its cartesian coordinates, is integrated, its three cartesian coordinates are separately integrated (which, therefore, requires three integrations). Mathematically stated, to perform $\bar{b} = \int \bar{Z}\, dt$, what really must be performed is:

$$b_1 = \int Z_1 dt ;$$

$$b_2 = \int Z_2 dt ; \text{ and}$$

$$b_3 = \int Z_3 dt.$$

If we let $\bar{Z} = \bar{b} \times \bar{Y}$ in the above example, we know from the definition of cross products that:

$$Z_1 = b_2 Y_3 - b_3 Y_2 ;$$

$$Z_2 = b_3 Y_1 = b_1 Y_3 ; \text{ and}$$

$$Z_3 = b_1 Y_2 - b_2 Y_1 ;$$

and, therefore, the vector calculus equation

$$\bar{b} = \int \bar{b} \times \bar{Y}\, dt$$

is solved by solving the following three scalar calculus equations:

$$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt ;$$

$$b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt ; \text{ and}$$

$$b_3 = \int (b_1 Y_2 - b_2 Y_1)\, dt$$

We have examined the particular equation

$$b = \int \bar{b} \times \bar{Y} \, dt$$

because an understanding of this particular equation is essential to an understanding of the claims in suit. With this knowledge in hand, the analysis of the legal issues in this case may be more easily perceived.

APPENDIX 2

IN THE UNITED STATES COURT OF CLAIMS

TRIAL DIVISION

No. 431-75

(Filed: May 11, 1979)

GEORGE ARSHAL

v.

THE UNITED STATES

ON DEFENDANT'S MOTION AND PLAINTIFF'S CROSS-MOTION FOR SUMMARY JUDGEMENT

OPINION*

BROWNE, *Trial Judge:* This action is brought by George Arshal (plaintiff) against the United States (defendant) under the provisions of 28 U.S.C. § 1498(a) for recovery of reasonable and entire compensation for the alleged use or manufacture by or for defendant of the invention covered by claims 2, 3, 6, and 7[1] of his

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* The opinion and conclusion of law are submitted in accordance with Rule 54(b).

[1] The text of the asserted claims is set forth in Appendix A, *infra*.

United States Patent No. 3,319,052 (the '052 patent), issued May 9, 1967, for a "Directional Computer." The application on which the patent is based was filed January 20, 1966 (Serial No. 533,106) as a continuation of a subsequently abandoned application (Serial No. 206,801) filed July 2, 1962.

Defendant moved for summary judgment on March 30, 1978, on the issue of validity, and plaintiff moved for summary judgment on April 7, 1978, on the issues of validity, infringement, and license. The court referred the motions to the trial judge on July 25, 1978, pursuant to Rule 54 for his opinion and recommendation for the conclusion of law.

Upon review of the motions, supporting briefs, and extensive oral arguments of both parties heard on February 7 and 8, 1979, we have concluded that the '052 patent is invalid but, if valid, is infringed; wherefore, plaintiff is not entitled to recover on his claim for reasonable and entire compensation. Accordingly, defendant's motion for summary judgment is granted, plaintiff's motion for summary judgment is denied and, since the holding of invalidity is dispositive of the case, the petition is dismissed.

I. *The Pleadings and Pretrial Proceedings*

A. *The Pleadings*

Plaintiff filed his petition, *pro se*, on December 12, 1975, after having failed to negotiate an administrative

settlement of his claim with the Department of the Navy. In his petition, plaintiff alleges that claims 2, 3, 6, and 7 of his patent are infringed by the guidance system manufactured for and used by defendant in its Poseidon missile, and also by the guidance system intended for use in the Trident C4 (Trident) missile. Lockheed Missiles and Space Company, Inc., of Sunnyvale, California (Lockheed) is alleged to be the sole manufacturer of the missiles for the defendant.

Defendant filed its answer to the petition on April 9, 1976. In its answer defendant admitted that the Poseidon missiles were supplied by Lockheed and used by defendant, and that certain plans exist with respect to manufacture and use of the Trident C4 missile by defendant. Defendant denied, however, that the patent has been infringed or that it was duly and legally issued, or otherwise enforceable. Defendant contends that, in any event, it is licensed under the patent in suit.

B. *Pretrial Proceedings*

On April 20, 1976, the trial judge filed an "Inquiry re Further Proceedings" in which the parties were requested to inform the trial judge as to their intentions with respect to the conduct of further proceedings. It appeared from their responses that the case would not be settled by negotiation and that discovery would be necessary. Consequently, an order was issued on May 11, 1976, calling for completion of discovery by August 31, 1976, with the parties being required to file and

serve their respective pretrial submissions in accordance with Rule 111(g), with a view to commencing trial prior to December 31, 1976 (a little more than 1 year after the date of filing the petition).

Voluntary discovery was hampered to some extent by virtue of security classification of certain of defendant's documents pertaining to missile guidance systems. Through mutual cooperation, however, these obstacles were overcome and plaintiff ultimately obtained access to all of the documents he required. As a consequence of this delay, however, it was not possible to commence trial by December 31, 1976. A final pretrial conference was held on January 19, 1977, at which time it was concluded that the parties might work out a joint stipulation of facts whereby the matter might be submitted for determination under Rule 134(b), or at least to narrow the issues of fact to be tried. When it first appeared that progress was not being made because the parties were having difficulty in reaching an agreement as to the uncontested issues of fact, a further pretrial order on liability was issued on May 27, 1977. The purpose of this order was to enable the parties to better organize the material submitted in response to the order of May 11, 1976, either for trial or for submission of the case on stipulated facts under Rule 134(b).

As a consequence of the efforts of the trial judge and of the parties, much documentation has already been received in evidence and filed with the clerk. To

the extent that the pending motions for summary judgment make reference to such evidence, it has been taken into consideration in rendering the present opinion and making the present recommendation for the conclusion of law.

II. *The Patent in Suit*

In order to comprehend the legal issues of this case, it is necessary first to have a basic understanding of the underlying mathematics of the invention, since it involves vectors, vector algebra, and vector calculus. A very brief discussion of these concepts is presented in Appendix B of this opinion. The discussion which follows presumes both a basic knowledge of elementary algebra and an understanding of the appended discussion of vector mathematics.

The '052 patent is entitled, "Directional Computer." It defines the invention as "a vectorial data processing system for extracting or prescribing directions and their rates of change from given input vectors." *See*, column 1, lines 13-15 of the patent. The specification specifically states that the output direction is affected by the input vector in one or both of the following two ways:

(1) So that the output direction rotates around the input vector to describe a conical surface,

(2) So that the output direction rotates directly towards the input vector and seeks coalign-

ment. [*Id.* at col. 1, lines 27-31.]

The system is described as useful in aircraft flight control, as one example. It is also intended for use to "service demanding applications requiring wide ranging directional controls under a variety of options." [*Id.* at col. 1, lines 52-57.] The remaining portion of the specifi cation describes the invention primarily in terms of vector algebra. The drawings illustrate examples of the relationship of the algebraic expressions disclosed in the specification in terms of circuit diagrams and other graphic symbols.

III. *Validity of the Claims Under 35 U.S.C. § 101*

A. *The Positions of the Parties*

Defendant has alleged in its motion for summary judgment that claims 2, 3, 6, and 7 of the patent are invalid because they are drawn to subject matter which is not patentable under the Patent Act of 1952 (Title 35, United States Code). Specifically, defendant contends that the claims, essentially, are drawn to a mathematical equation, and that a mathematical equation is not patentable subject matter under 35 U.S.C. § 101 (1976).[2]

Claim 2 of the patent is illustrative of all of the

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[2] 35 U.S.C. § 101 states: "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."

claims in suit and states:[3]

> 2. A directional computer comprising
>
> (a) a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity,
>
> (b) means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector, and
>
> (c) means to receive the said input signals and generate a plurality of output signals *expressing an output vector in relation to said reference frame as the integral of the cross product vector between the said output vector and the said input vector*, whereby the said output vector rotates around said input vector. [Emphasis added.]

To support its position that claim 2 is essentially directed to a mathematical equation, defendant points to the italicized phrase in part (c) of claim 2. (This language also appears in the remaining claims in suit, namely, claims 3, 6, and 7). Although plaintiff does not dispute that this language is the verbal equivalent of a

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[3] The claim has been broken down into three parts for analytical purposes. It does not appear in this format in the patent.

mathematical expression,[4] plaintiff points out that this language forms only a portion of the claim and that, when considered in its entirety, the claim is not directed to an equation, but to a *machine*.

B. *The Applicable Law*

Since mathematical expressions or equations, *per se*, are not susceptible to patent protection under section 101 of the Patent Act,[5] we must determine whether or not the asserted claims define an invention which is merely a mathematical expression or equation. If the mathematical expression or equation is simply an adjunct to the invention sought to be covered, the inclusion thereof in the claims is not fatal to their validity. If, however, the invention itself can be expressed only in terms of the mathematical expression or equation, it is outside the scope of 35 U.S.C. § 101 and, therefore, is invalid under the applicable case law.

Tests for determining whether a claim is directed to

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[4] Specifically, the language recites the mathematical expression $\overline{b} = \int(\overline{b} X \overline{Y})\, dt$, where $\overline{Y}$ represents a desired input vector and $\overline{b}$ represents a directional output vector.

[5] Section 101 of the Patent Act, *see* fn. 2, *supra*, does not expressly *exclude* a mathematical expression or equation as patentable subject matter. Case law, however, has established that they are not included. *See e.g., Gottschalk* v. *Benson*, 409 U.S. 63, 175 USPQ 673 (1972); *Mackay Co.* v. *Radio Corp.*, 306 U.S. 86, 40 USPQ 199 (1938).

subject matter which is not patentable have been applied in some cases which predated the 1952 Patent Act, and many others subsequent to that Act. In some early cases, because the "point of novelty" or truly novel element in the claims was determined to be a mathematical expression or equation, the claims were held to be nonstatutory.[6] *See e.g., In re Abrams*, 188 F.2d 165, 89 USPQ 266 (CCPA 1951).

The "point of novelty" test was, at first, followed after the effective date of the 1952 Act, but was formally rejected by the Court of Customs and Patent Appeals (CCPA) in *In re Bernhart*,[7] 417 F.2d 1395, 163 USPQ 611 (CCPA 1969).[8] In *Bernhart*, among the claims before the court was an apparatus claim directed to a general purpose computer programmed to calculate the

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6 The word "nonstatutory" is sometimes used to apply to a claim directed to subject matter which is not expressly entitled to patent protection.

7 As a point of fact, the CCPA first rejected this approach in *In re Prater*, 415 F.2d 1378, 159 USPQ 583 (CCPA 1968). However, the opinion in *Prater* was subsequently vacated, 415 F.2d 1378, 160 USPQ 230, and replaced by an opinion which did not discuss the propriety of the "point of novelty" test, *see* 415 F.2d 1393, 162 USPQ 541 (CCPA 1969).

8 The decisions of the Court of Customs and Patent Appeals, while being neither controlling nor binding on this court, are nevertheless accorded great weight and respect in view of the manifest expertise of that court in determining whether or not claims presented in pending applications for patents satisfy the requirements of the patent statutes.

results of a complex mathematical equation. In reversing the Examiner's rejection of this claim (which was based upon the Examiner's belief that the novelty of the claim lay in the equations with which the computer was programmed), the court stated:

> The principle [behind the Examiner's rejection] may, we think be fairly stated as follows: If, in an invention defined by a claim, the novelty is indicated by an expression which does not itself fit in a statutory class (in this case not a machine part thereof), then the whole invention is nonstatutory since all else in the claim is old. We do not believe this view is correct under the Patent Act and the case law thus far developed. [*Id.* at 1399, 163 USPQ at 615-16.]

Instead, the court concluded that:

> [I]f a machine is programmed in a certain new and unobvious way, it is physically different from the machine without that program; its memory elements are differently arranged. The fact that these physical changes are invisible to the eye should not tempt us to conclude that the machine has not been changed. If a new machine has not been invented, certainly a "new and useful improvement" of the unprogrammed machine has been, and Congress has said in 35 U.S.C. 101 that such improvements are statutory subject matter for a patent. [*Id.* at 1400, 163 USPQ at 616.]

The CCPA reaffirmed its rejection of the "point of novelty" test in *In re Musgrave*, 431 F.2d 882, 167 USPQ 280 (CCPQ 1970), and pointed out the fallacy in that test:

> [I]t is our view that [the point of novelty test is] logically unsound. According to [this test], a process containing both "physical steps" [the statutory portion] and so-called "mental steps" [the nonstatutory portion] constitutes statutory subject matter if the "alleged novelty or advancement in the art resides in" steps deemed to be "physical" and nonstatutory if it resides in steps deemed to be "mental". It should be apparent, however, that novelty and advancement of an art are irrelevant to a determination of whether the nature of a process is such that it is encompassed by the meaning of "process" in 35 U.S.C. 101. Were that not so, as it would not be if [the point of novelty test] were the law, a given process including both "physical" and "mental" steps could be statutory during the infancy of the field of technology to which it pertained, when the physical steps were new, and non-statutory at some later time after the physical steps became old, acquiring prior art status, which would be an absurd result. Logically, the identical process cannot be first within and later without the categories of statutory subject matter, depending on such extraneous factors. [*Id.* at 889, 167 USPQ at 286-87.]

Instead, the court stated that all that was needed to make the claimed process statutory under 35 U.S.C. § 101 was "that it be in the technological arts so as to be in consonance with the constitutional purpose to promote the progress of 'useful arts'." 431 F.2d at 893, 167 USPQ at 289-90. Finding the claims at issue to be within the technological arts, the court reversed the examiner's rejection.

The new "technological arts" test was reaffirmed by the CCPA in *In re Foster*, 438 F.2d 1011, 169 USPQ 99 (CCPA 1971), as it stated that "it is not important whether the claims contain mental steps [the nonstatutory portion] or not if the process is within the technological arts." *Id.* at 1011, 169 USPQ at 101. And in *In re Waldbaum*, 457 F.2d 997, 173 USPQ 430 (CCPA 1972), the CCPA explained that "[t]he phrase 'technological arts', as we have used it, is synonymous with the phrase 'useful arts' as it appears in Article I, Section 8 of the Constitution." *Id.* at 1003, 173 USPQ at 434.

In *In re Benson*, 441 F.2d 682, 169 USPQ 548 (CCPA 1971), the CCPA again applied their "technological arts" test to reverse a section 101 rejection of a claim drawn to a method of converting one form of numerical representation into another, utilizing a novel algorithm. After concluding that the process had no practical use except in connection with a digital computer, the court stated:

> It seems beyond question that the machines - the computers - are in the technological field, are a

> part of our best-known technologies, and are in the "useful arts" rather than the "liberal arts" as are all other types of "business machines," regardless of the uses to which their users may put them. How can it be said that a process having no practical value other than in enhancing the internal operation of these machines is not likewise in the technological or useful arts? We conclude that the Patent Office has put forth no sound reason why the claims in this case should be held to be nonstatutory. [*Id.* at 688, 169 USPQ at 553.]

Certiorari was granted in *Benson*, and the Supreme Court, however, *reversed*. *Gottschalk* v. *Benson*, 409 U.S. 63, 175 USPQ 673 (1972). The Supreme Court began by pointing out that the case law has well established the principle that one may not patent an *idea*. Directing its attention to the *claims* at issue, the Court found two fatal objections to their validity: first, that "the claims were not limited to any particular art or technology, to any particular apparatus or machinery, or to any particular end use", *id.* at 64, 175 USPQ at 674, but were "so abstract and sweeping as to cover both known and unknown uses" of the *claimed* invention, *id.* at 68, 175 USPQ 675; and second, that because the mathematical formula embodied in the *claims* had "no substantial practical application except in connection with a digital computer", "the patent [claims] would wholly pre-empt the mathematical formula and in practical effect would be a patent on the algorithm itself." *Id.* at 71-72, 175

USPQ at 676.

The determination of whether a *claim* preempts non statutory subject matter under the rationale of *Benson* has been determined to require a two-step analysis:

> First, it must be determined whether the claim recites an "algorithm" in the Benson sense of that term, for a claim which fails to even recite an algorithm clearly cannot wholly preempt an algorithm. Second, the claim must be further analyzed to ascertain whether in its entirety it wholly preempts that algorithm. [*In re Freeman*, 573 F.2d 1237, 1245, 197 USPQ 464, 471 (CCPA 1978)].

We now direct our attention to that analysis.

Plaintiff contends that his claims do not recite an "algorithm" in the *Benson* sense, but are directed to "physical geometry." (*See* plaintiff's response to defendant's motion for summary judgment under Rule 101 (filed May 3, 1978) at p. 43.) Specifically, plaintiff states that his claims are distinguishable from those in *Benson* because his are "concerned with creating a circumstance," while those in *Benson* are concerned with "determining the value of a variable that already exists in the context of a specific set of circumstances." *Id.* We find, however, this distinction, if it is one at all, to be of no consequence. The important point is that the claims both in *Benson* and in this suit are directed to a particular means for transforming defined input signals into useful output signals. Although *Benson* did not render all algorithms (as defined by the

dictionary) to be nonstatutory, subsequent case law has clearly established that a formula or equation, even if expressed in its prose equivalent, is the type of subject matter to which the *Benson* rationale must be applied. *See In re Freeman*, 573 F.2d at 1246, 197 USPQ at 471 (and cases cited therein).

Plaintiff further argues that *Benson* is inapplicable because the claims in *Benson* are drafted in the form of a "method," whereas the claims in this suit are drafted in the form of an "apparatus" (using "means plus function" language).[9] However, even the language used in *Benson* itself indicates that the fundamental principles governing the statutory determination of "method" claims is equally applicable to "apparatus" claims:

> As we stated in *Funk Bros. Seed Co. v. Kalo Co.*, "He who discovers a hitherto unknown phenomenon of nature has no claim to a monopoly of it which the law recognizes. If there is to be invention from such a discovery, it must come from the application of the law of nature to a new and useful end." *We dealt there with a "product" claim while the present case deals only with a "process" claim. But we think*

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[9] It should be noted that plaintiff, who prosecuted his patent application *pro se*, did not have the benefit of the courts' decisions rendered after May 9, 1967, since the patent issued on that date was based on his application which was first filed in 1962 and refiled in 1966. *In re Abrams*, *supra*, was the only significant precedent available during the pendency of plaintiff's applications.

> *the same principle applies.* [409 U.S. at 67-68, 175 USPQ at 675 (citations omitted and emphasis added)].

As the CCPA stated in *In re Freeman*, it is not the form of the claim which is controlling but its substance:

> Though a claim expressed in "means for" (functional) terms is said to be an apparatus claim, the subject matter as a whole of that claim may be indistinguishable from that of a method claim drawn to the steps performed by the "means" * * *. [I]f allowance of a method claim is proscribed by *Benson*, it would be anomalous to grant a claim to apparatus encompassing any and every "means for" practicing that very method. [573 F.2d at 1247, 197 USPQ at 472 (footnote omitted)].

To do otherwise would make the determination of patentable subject matter depend simply on the draftman's skill which would ill serve the principles underlying the prohibition against patents for ideas. *See Parker* v. *Flook*, 437 U.S. 584, 593, 198 USPQ 193, 198 (1978).

Plaintiff finally urges that *Benson* is inapplicable because *Benson* dealt with an algorithm used only in digital computers, whereas plaintiff's patent discloses his equation for use in analog computers. While it is true that the Supreme Court in *Benson* expressly declined to extend its holding to algorithms used in analog

computers, [10] it is also true that they did not in any way disapprove of such an extension. As we can see no factual reason for making such a legal distinction, we believe that the rationale of *Benson* is equally applicable to algorithms used in analog computers. This conclusion, however, is unnecessary to our decision as the claims in suit are in no way limited to analog computers. That the specification may disclose analog computers in one embodiment of the claimed invention is irrelevant. Although the specification may be properly used to *interpret* limitations already present in the claims, *Westwood Chemicals, Inc. v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), the specification may never be used to *add* additional and otherwise nonexistent limitations to those claims, *Siegler v. Watson*, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). To be sure, not even plaintiff seriously contends that his claims do not encompass digital computers for plaintiff, himself, contends that defendant's alleged infringing computer, which is a digital computer, is fully encompassed by his patent claims. It is a fundamental principle of patent law that a claim may not be narrowly construed to avoid invalidity and then broadly

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[10] Specifically, the Court stated: "It is said that we have before us a program for a digital computer but extend our holding to programs for analog computers. We have, however, made clear from the start that we deal with a program only for digital computers." 409 U.S. at 71, 175 USPQ at 676.

construed to encompass the accused device. *See e.g., Dominion Magnesium Ltd. v. United States*, 162 Ct. Cl. 240, 319 F.2d 1872, 138 USPQ 306 (1963).

Accordingly, the rationale of *Benson* is applicable to a determination of validity of the claims in this case. The issue to which we now direct our attention is whether, under the rationale of *Benson*, these claims "wholly pre-empt the mathematical formula" which they incorporate.

C. *Application of the Law to the Claims*

1. *Claim 2*[11]

Claim 2 recites three elements which can, functionally, be summarized as follows:

(a) a physically defined, stabilized reference frame[12]

(b) means of obtaining input signals defining an input vector in relation to the stabilized reference frame; and

(c) means to calculate $\overline{b} = \int (\overline{b} \times \overline{Y})\, dt$,

where $\overline{Y}$ is the input vector, $\overline{b}$ is the output

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[11] For the full text of claim 2, see Appendix A, *infra*.

[12] This element is further described in the claim as "having means of sensing and suppressing its angular velocity." However, it is clear from the specification that this language merely clarifies the essential nature of a "stabilized reference frame" and thus is without limiting effect. *See* col. 5, lines 4-9. To be sure, plaintiff wholly agrees with this conclusion. *See* PRDMSJ at ¶ 49.

vector, and the integration is relative to the stabilized reference frame.[13]

The Supreme Court has indicated in *Benson* that a claim should be "limited to [a] particular art or technology, to [a] particular apparatus or machinery [and] to [a] particular end use." 409 U.S. at 64, 175 USPQ at 674. If we consider only element (c) of claim 2 for the moment, it is clear that it violates each and every requirement of this rule. First, it in no way specifies any use for the calculated output vector and, therefore, is not "limited to any particular end use." Second, the "means plus function" language encompasses any and every type of apparatus or machine which could be used to implement the claimed equation and, therefore, the element is not "limited to any particular apparatus or machinery." Finally, the element has application in arts or technologies as diverse as the equation itself

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[13] This element is further described in the claim by the language "whereby the said output vector rotates around the said input vector." However, this language has no limiting effect for it is clear that in every implementation of the claimed equation the "output vector rotates around the said input vector" whether it rotates to trace a conical surface around the input vector or seeks coalignment with it. *See also* n. 43, *infra*.

The statement that "the integration is relative to the stabilized reference frame" is used to mean what the inventor in his specifications has defined it to mean, namely that the vector quantities of the integrand, *i.e.*, $\overline{b}$ and $\overline{Y}$ are expressed in reference to the stabilized reference frame. *See* cols. 4 and 5, lines 64-75 and 1-4, respectively.

and, therefore, is not "limited to any particular art or technology." The element truly does, in the *Benson* sense, wholly preempt the mathematical formula which it embodies.

Of course, claim 2 recites more than merely element (c). However, the effect of additional elements (a) and (b) in claim 2 is insufficient to factually or legally distinguish the claim from the type held to be unpatentable in *Benson*. The reason for this conclusion becomes clear upon an understanding of the purpose of these elements.

As we have stated above, element (c) merely calls for means to perform a mathematical computation which, by itself, is unpatentable subject matter. Because the equation recited in element (c) is a calculation using an input vector, *i.e.*, $\overline{Y}$, apparatus performing that calculation necessarily requires means to generate the value of the input vector, $\overline{Y}$. Element (b) is for just that purpose and, therefore, is essential to the performance of the computation. Thus, the "limitation" in the claim effectuated by the addition of element (b) is, for all practical purposes, not a limitation at all because element (c) cannot function in the absence of element (b). Of course, if element (b) recited apparatus which generated a *particular* type of input signal, such as a specified physical quantity, our conclusion might be different. But it does not, and, in fact, it states that the input signals defining the input vector may be representative of "any desired value."

The same is true of element (a). Because the equation claimed in element (c) operates exclusively on vectors, as we have point out in our background mathematics discussion, Appendix B, *infra*, all vectors *must* be expressed in terms of a frame of reference and, therefore, a reference frame is also essential to the implementation of the claimed equation.[14] This is the purpose of element (a) and it too, therefore, is essential to the performance of the computation claimed in element (c). While it is true that element (a) is limited to a particular type of reference frame, *i.e.*, a "physically defined, stabilized reference frame," the very nature of the claimed equation requires this specific type of reference frame to produce a meaningful result.[15]

In *In re Christenson*, 478 F.2d 1392, 178 USPQ 35 (CCPA 1973), the CCPA was presented with a similar case. The claim at issue contained a mathematical

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[14] Plaintiff wholly agrees with this statement. *See* n. 25, *infra*.

[15] The claimed equation, $\overline{b} = \int \overline{b} \times \overline{Y}\, dt$, is but one embodiment of the more general equation

$$\overline{b} = \int ((A/b^2 - B)\overline{b} + \overline{b} \times \overline{Y} + \overline{b} \times \overline{w})\, dt,$$

(*see* col. 4, equation (17)) with $A/b^2 - B = \overline{w} = 0$ by definition. To make $\overline{w}=0$, however, *requires* a "physically defined, stabilized reference frame." *See* col. 5, lines 1-7. Thus, the claimed equation cannot be meaningfully implemented with any other type of reference frame. *Accord, see* plaintiff's submission to standard pretrial order on liability (PSPOL), ¶ 23, 24 (filed February 27, 1978).

equation and several "data gathering" steps. In rejecting the contention that the addition of "data gathering" steps could convert a nonstatutory claim into statutory subject matter, the court said:

> Given that the *method of solving* a mathematical equation may not be the subject of patent protection, it follows that the addition of old and necessary antecendent *steps of establishing values for the variables in the equation* cannot convert the unpatentable method to patentable subject matter. [*Id.*, at 1394, 178 USPQ at 37-38 (emphasis supplied)].

The rationale behind this pronouncement of law was later explained by Chief Judge Markey in *In re Sarkar*, 588 F.2d 1330, 200 USPQ 132 (CCPA 1978):

> No mathematical equation can be used, as a practical matter, without establishing and substituting values for the variables expressed therein. Substitution of values dictated by the formula has thus been viewed as a form of mathematical step. If the steps of gathering and substituting values were alone sufficient, every mathematical equation, formula, or algorithm having any practical use would be per se subject to patenting as a "process" under § 101. [*Id.*, at 1335, 200 USPQ at 139.]

Even where the antecendent "data gathering" steps are novel and unobvious, their recitation in combination with a mathematical computing step is legally insuffi-

cient to give rise to a patentable claim under § 101 of the Patent Act. *In re Richmann*, 563 F.2d 1026, 195 USPQ 340 (CCPA 1977); *accord*, *In re Sarkar*, *supra*, at n. 18.

Of course, these CCPA precedents dealt with claimed *processes*, not *apparatus*. However, as we have already pointed out, the controlling principles are the same. Otherwise, the anomaly might result that a claim to apparatus encompassing any and every means for performing a method might be valid while, at the same time, a claim encompassing all methods of obtaining the desired result might be proscribed by *Benson*. *In re Freeman*, 573 F.2d at 1247, 197 USPQ at 472.

Plaintiff maintains, however, that claim 2 does not preempt a mathematical equation because the preamble "[a] directional computer" adequately limits the scope of the claim to a particular technology, *i.e.*, the directional computer technology. We find as a matter of law, however, that those words do not effectively limit the claim to any *particular* technology.[16]

First of all, computers are applicable to all technologies, not to any *particular* technology. Although the type of computer is specified as a "directional" computer, in the present case, this is a limitation

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16 While the specification describes the invention as being a "vectorial data processing system" which is useful in "aircraft flight control," all of the claims are directed to a "directional computer," without recitation or limitation as to *any* field of use.

without substance because vector computations (the type of computation recited in the claim), by definition, include directional computations. Thus, the claimed mathematical formula already intrinsically calls for directional computations and, therefore, use of the word "directional" in the preamble creates no additional limitation.

Second, there is a substantial question whether words in a preamble which do not appear in the body of the claim may even properly be used to limit the scope of the claim. *See e.g., Strador v. Watson*, 244 F.2d 737, 113 USPQ 365 (D.C. Cir. 1957). Where, as here, the effect of the words are at best ambiguous (*i.e.*, as pointed out above, there is uncertainty whether the words have any limiting effect on the scope of the claim), a compelling reason must exist before the language can be given weight. *Cf. In re de Castelet*, 562 F.2d 1236, 1244, n. 6, 195 USPQ 439, 447, n. 6 (CCPA 1977) ("Where there is a potential for misconstruction of preamble language, a compelling reason must exist before the language can be given weight.") We can see no such reason in this case, for the language in the body of claim 2, standing alone, is clear and unambiguous.

Even assuming, *arguendo*, that the preamble language "[a] directional computer" does have the effect of limiting the scope of claim 2 to a particular technology, the fact remains that claim 2 still preempts a mathematical equation, albeit in a limited and specific application. As the CCPA established in *In Re Wald-*

baum, 559 F.2d 611, 194 USPQ 465 (CCPA 1977), preemption of a mathematical calculation is fatal to the validity of a claim regardless of the scope of that preemption:

> [C]aims 1, 2 and 19 do not represent "no less of a 'computer processing program' than did claim 8 in *Benson*," because they are limited to the specific application of calculating the number of busy and idle lines in a telephone system. They would not preempt all uses of the algorithm [citing uses of the algorithm outside of the claimed invention], but would preempt only the use of the algorithm in calculating the number of busy and idle lines in a telephone system. At the same time, it must be recognized that a patent on these claims would, in practical effect, be a patent on the algorithm itself - albeit in its limited, specific application to calculating the number of busy and idle lines in a telephone system.* * * * *
>
> In view of the foregoing, we hold that claims 1, 2 and 19 do not define a statutory process within the meaning of 35 USC 100 and 101. [*Id.* at 617, 194 USPQ at 469-70 (footnotes omitted).

Similarly, the Supreme Court recently held in *Parker* v. *Flook*, 437 U.S. 584, 595, 198 USPQ 193, 199 (1978), that "a claim for an improved method of calculating, even when tied to a specific end use, is unpatentable subject matter under § 101."

It is important to point out that a claim is not invalid merely because it recites a mathematical equation or computation. *Parker v. Flook, supra.* Rather, a claim reciting a mathematical equation or computation as one of its elements will be invalid only if, when considered in its entirety, the essence of the claim is nothing more than that element. Although the line of demarcation between a patentable and an unpatentable (or non-patentable) claim "does not always shimmer with clarity," *Id.*, a persuasive index of a valid mathematical-calculating type of claim is when the claimed computation or equation is used not merely to calculate a numerical value, but is used to effectuate a physical result. For example, the CCPA recently held a series of claims directed to methods for removing unwanted noise from seismic data not to be invalid under § 101 because the purpose of the claimed invention was to "filter out extraneous and erroneous components and to physically record a noiseless seismic trace on a record medium," rather than to merely "compute a new value." *In re Johnson*, 589 F.2d 1070, 200 USPQ 199 (CCPA 1978). As is apparent from a reading of claim 2 of the patent in suit, however, the sole purpose of the invention recited therein is merely to "compute a new value." Thus, for this reason and all of the reasons discussed above, we conclude that, under the rationale of *Benson* and its progeny, unlike the claims in *Johnson*, claim 2 is invalid.

2. *Claim 6*[17]

We find the additional language placed in the remaining claims in suit insufficient to distinguish them from nonstatutory claim 2, as a matter of law. With respect to claim 6, the parties agree that it differs from claim 2 in that it calls for the following additional elements:

(d) a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween,

(e) the input signals being referred to the second reference frame to express an input vector, and

(f) the "means" receiving the input signals and generating the output signals to include the coordinate transformation means in (d) above.

See PRDRFA at ¶ 21. The essential difference between claim 6 and nonstatutory claim 2, therefore, is that claim 6 calls for an *additional* data gathering element, the "second reference frame," and for an additional mathematical calculating element, the "means to perform a coordinate transformation."[18]

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[17] The full text of claim 6 is recited in the Appendix A, *infra*.

[18] The specifications disclose that the "means to perform a coordinate transformation" is merely apparatus which performs a series of known mathematical computations. *See* cols. 6 and 7, lines 15-17 and 1-3, respectively.

Certainly, the addition of a second mathematical calculating element (an element which is on its face nonstatutory), cannot change a nonstatutory claim into one which is statutory; and we think that, given the principle that the addition of a "data gathering" element cannot change an otherwise nonstatutory claim into a statutory claim, the inclusion of an *additional* "data gathering" element in the claim will also not have that effect. Accordingly, we conclude that claim 6 does not define an invention which is entitled to patent protection under 35 U.S.C. § 101. We now consider the effect of the differences between claim 3 and claim 2.

3. *Claim 3*[19]

When the value of the output vector, $\overline{b}$, recited in claim 2 is computed, as we have explained in the mathematical background discussion, *infra* at Appendix B, what is actually computed is the scalar values of the output vector's three projections on the axes of a cartesian coordinate reference frame, *i.e.*, b_1, b_2, and b_3. Thus, while claim 2 recites only a single mathematical equation, *i.e.*, $\overline{b} = \int (\overline{b} \times \overline{Y})\, dt$, the solution of that equation requires the following three separate computations (a fact not disputed by the parties):[20]

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19 The full text of claim 3 is presented in Appendix A, *infra*.

20 The derivation of these equations is shown in the background mathematics discussion, *infra* at Appendix B.

$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt;$

$b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt;$ and

$b_3 = \int (b_1 Y_2 - b_2 Y_1)\, dt.$

Claim 3, on the other hand, expressly limits its scope by defining only the third axis projection (Y_3) with respect to the reference frame. Unlike claim 2, the remaining projections of the input vector (*i.e.*, Y_2 and Y_1) are not expressly defined. Also, unlike claim 2, only *two* of the projections of the output vector are calculated (b_1 and b_2),[21] rather than the full set (b_1, b_2, and b_3) calculated by the apparatus recited in claim 2. Based upon this analysis (the accuracy of which is not disputed), the only difference between claim 3 and claim 2 is that claim 3 calls for apparatus which performs only *two* computations, while claim 2 intrin-

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21 The parties dispute the implication to be drawn from the failure of the claim to expressly define the value of two of the three projections of the input vector (*i.e.*, Y_2 and Y_1). Plaintiff contends that the inference to be drawn is that they may be of any value. Thus, plaintiff contends, the two claimed computations are

$b_1 = \int (b_2 Y_3 - b_3 Y_2)\, dt$ and

$b_2 = \int (b_3 Y_1 - b_1 Y_3)\, dt$

which are identical to two of the three computations claimed in claim 2. Defendant contends that the only proper interpretation of claim 3 is that the two unnamed projections (Y_2 and Y_3) must be consistently zero. Thus, defendant contends, the two claimed computations are

$b_1 = \int (b_2 Y_3) dt$ and $b_2 = \int (-b_1 Y_3)\, dt$

sically calls for apparatus which performs *three* computations. This difference, however, does not make claim 3 any less "abstract" or "sweeping" in the *Benson* sense than claim 2. It merely alters the quantity and perhaps the substance[22] of the computations claimed, not the fact that a computation has been claimed. We conclude, therefore, that claim 3 is also invalid under the rationale of *Benson*.

4. *Claim 7*[23]

Claim 7 is identical to claim 6, except that it incorporates the language which distinguished claim 3 from claim 2. In other words, claim 7 is identical to claim 6, except that it calls for only *two* computations as opposed to the *three* computations called for by claim 6. Accordingly, for the same reasons given above for finding claim 3 nonstatutory, claim 7 is also directed to nonstatutory subject matter.

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which are *not* identical to any of the three computations claimed in claim 2. However, although the resolution of this issue is of obvious importance to the question of infringement, it is irrelevant to the issue of claim validity under § 101 because, regardless of which interpretation is correct, the fact remains that a computation has been claimed.

[22] *See* n. 21, *supra*.

[23] The full text of claim 7 is presented in Appendix A, *infra*.

In summary, we have concluded that all of the claims in suit are invalid under the rationale of *Benson* and its progeny, because they preempt the mathematical formulae which they embody and, in practical effect, claim the mathematical formula itself. This conclusion, we think, is fortified by plaintiff's own admission that his invention is disclosed in a certain report, but that this report does not disclose *any* hardware or structure, *only mathematical equations.* *See* PRDRA at ¶ 17.

IV. *Validity of the Claims Under 35 U.S.C. § 103*

Defendant also contends that the subject claims are invalid because they fail to meet the requirements of section 103 of the Patent Act.[24] While the defendant has enumerated many grounds for this defense in its response to this court's standard pretrial order on liability (filed May 27, 1977), it has chosen to rely upon only two of these grounds in its motion for summary judgment.

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[24] Section 103 provides: "Conditions for patentability; non-obvious subject matter. A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made."

Defendant's first ground is that "claims 2, 3, 6 and 7 are invalid for obviousness because the distinguishing features on which their allowance [by the Examiner] was based were old." In particular, defendant contends that the file wrapper of the subject patent establishes that claims 2, 3, 6, and 7 were allowed over the prior art *only* because they were finally amended to specifically include a reference frame "having means of sensing and suppressing its angular velocity," and that, because plaintiff has admitted that such an element is itself old,[25] under *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), the claims must be held to be invalid. Our analysis of the underlying legal and factual basis for this contention, however, leads us to the conclusion that it is wholly without merit.

It is true that in *Graham* the Court did state that because the "patentee obtained his patent only by accepting the limitations imposed by the examiner," [t]he subject matter as a whole reduces, then to the[se] distinguishing features." *Id.* at 33-34, 148 USPQ at 473. However, it is equally true that the prior art which the Court relied upon to invalidate the patent claims under consideration disclosed many

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[25] Specifically, plaintiff has admitted that "a physically defined stabilized reference frame having means of sensing and suppressing its angular velocity" is disclosed in U.S. Patent No. 2,752,793 to Draper, *et al.* (filed in 1951). *See* PRDRA at ¶ 42.

elements of the claim in addition to the "distinguishing features." Thus, this case does not really stand for the proposition that a claim is automatically invalidated by prior art merely because it discloses *in isolation* those elements of a claim upon which allowance of the claims was based. To the contrary, it is settled law that validity of a claim must be judged by the claimed subject matter *taken as a whole*. *E.g.*, 35 U.S.C. § 103; *Parker* v. *Flook*, 437 U.S. at 594, 198 USPQ at 199.

Defendant's contention is not only unsupported by the law, but its basic factual premise, *i.e.*, that the distinguishing feature of the claims is old, is erroneous. Although it is true that the claims were allowed over the prior art only after they were amended to recite a *reference frame* "having means of sensing and suppressing its angular velocity," contrary to defendant's assertion, this did not mean that the examiner viewed this special type of reference frame as the *sole* distinguishing feature of the claims. To the contrary, the prosecution history clearly demonstrates that the claimed *equation*, not the special type of reference frame, was the material "distinguishing feature" of the claims,[26] and defen-

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[26] Prior to allowance, the claims were rejected on prior art which disclosed the equation

$$\bar{V} = \int_F \bar{A} dt - \int_F \bar{w} \times \bar{V} dt,$$

where $\bar{w}$ represented the angular velocity of a physically defined reference frame F, and $\bar{A}$ and $\bar{V}$ were

dant has not even alleged, much less demonstrated, that the claimed *equation* existed in the prior art.

Defendant's second ground is that the claims are invalid for obviousness because they call for hardware which would have been obvious from a knowledge of the claimed equation. While this may be true,[27] as we have pointed out heretofore, defendant has not even asserted, let alone established, that the

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other vectors referenced to F (note that the claimed equation is $\overline{b} = \int \overline{b} \times \overline{Y}\, dt$). The examiner stated that the prior art teaches "the integral of the cross product of two vector quantities" and that it "is not of patentable significance what variable the applicant claims his vectors represent." In response, the applicant contended that it was not proper to equate the prior art angular velocity vector, $\overline{w}$, with the input vector, $\overline{Y}$, because the angular velocity vector, $\overline{w}$, of his reference frame was always of zero value. Thus, the applicant contended, it was "impossible to derive from the 'teaching of [the prior art]' a device that is equivalent to mine." Although the examiner apparently was persuaded by this argument, he did not see how the claims limited the rotational velocity vector, $\overline{w}$, to a zero value and, accordingly, saw no difference between the equation *claimed* and the equation in the *prior art*. Although the applicant felt the limitation on $\overline{w}$ was already implicit in his claims, he added the language "having means of sensing and suppressing its angular velocity" *to the reference frame* so as to explicitly force $\overline{w}$ to a zero value. Thus, the addition of this crucial language was not to distinguish the claimed reference frame from the prior art, but to distinguish the claimed *equation* from the prior art.

[27] Plaintiff has already admitted that all of the claimed elements, except the equation, were old. *See* PRDRA at ¶¶ 16(b), 22, 28, and 42. Plaintiff also has admitted that the "hardware or structural means of

claimed equation was known in the art. Accordingly, we fail to see how the invention as a whole, as defined by the claims, would have been obvious to those skilled in the art, since those skilled in the art could not have been aware of the equation on which the remaining claim elements depend. Defendant's answer to this dilemma is that the equation is a "principle or natural law" and, as such, must be presumed to have been known, whether or not it was, in fact, known. We disagree.

Every invention works only because the "laws of nature" permit it to do so. Accordingly, to irrefutably presume *knowledge* of all laws of nature by those skilled in the art would be tantamount to presuming knowledge of the very reasons why the invention works. Once these *reasons* are presumed to be known to those skilled in the art, however, the invention will almost invariably be obvious to them.

In addition to rendering almost every worthwhile invention obvious, application of defendant's theory would discourage inventors in the future from disclosing the principles behind the operation of their inventions, fearing that such disclosure would be used against them as a mere use of a "principle of

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implementing the concepts" presented in his paper which "discloses the 'directional computer' *without disclosing hardware or structure*" "are sufficiently taught in plaintiff's [prior art] patent 2,923,465 issued February 2, 1960." [Id. at ¶17 (emphasis added)].

nature" to destroy the patentability of their inventions. The result would be a severe frustration of the very purpose of the patent system.

Thus, the *obviousness* of the invention must be judged against only that which was, in fact, *known* — nothing more. The cases defendant has cited in support of its position[28] are, in our opinion, of little relevance. Not only were they all decided before the statutory test of "obviousness" was enacted,[29] but a close analysis of each reveals that the courts were really addressing the question of whether the inventions under consideration were the kind of inventions to which Congress intended to afford patent protection,[30] not whether they were obvious over the prior art. Accordingly, defendant's motion for summary

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28 Defendant relies upon *Funk Bros. Seed Co.* v. *Kalo Co.*, 333 U.S. 127, 76 USPQ 280 (1948); *Davison Chemical Corp.* v. *Joliet Chemicals*, 179 F.2d 793, 84 USPQ 325 (7th Cir. 1950); and *Loew's Drive-In Theatres, Inc.* v. *Park-In Theatres*, 174 F.2d 547, 81 USPQ 149 (1st Cir. 1949).

29 The standard of "obviousness" was first expressed as a statutory requirement in § 103 of the 1952 Patent Act. Prior to this time, there was considerable confusion among the courts as to the proper test to be applied. Some courts examined the simplicity of the invention, others its manner of discovery, and others merely their own personal expertise.

30 For example, in *Funk Bros.*, *supra* at n. 28, the Court stated that they could not sustain the patent's validity "without allowing a patent to issue on one of the ancient secrets of nature now disclosed," *Id.* at 132, 76

judgment of invalidity based on the two assertions discussed above is denied.

V. *Infringement*

Plaintiff has moved for summary judgment on the issue of infringement alleging that claims 2, 3, 6, and 7 are infringed by the guidance system manufactured by Lockheed for defendant and used by defendant in the Poseidon missiles and proposed for use in the Trident missiles. Although the question of infringement becomes moot if the claims in suit are invalid, we have, nevertheless, given consideration to the infringement issue at this time for the sake of judicial economy in the event the holding of invalidity is not sustained. We begin by considering first the Poseidon missile.

USPQ at 282, a statement which implies to us that the patent was not drawn to the type of invention which Congress intended to be susceptible to patent protection -- a requirement which is now embodied in § 101 of the Patent Act. Indeed, the Supreme Court has just recently relied heavily on *Funk Bros.* in determining the proper scope of § 101. *See Parker* v. *Flook*, 437 U.S. at 591, 198 USPQ at 198.

A. *Application of Claim 2 to Poseidon*[31]

1. *Element (c) of Claim 2*[32]

Element (c) of claim 2, in essence, calls for means to calculate $\bar{b} = \int \bar{b} \times \bar{Y} dt$, where $\bar{Y}$ is an input vector, $\bar{b}$ is an output vector, and the integration is relative to a space stabilized reference frame.[33] Plaintiff claims that the computer on-board the Poseidon missile infringes this element twice by performing, at different points in time, the following two computations:

(a) $\bar{P} = \int \bar{w} \times \bar{P} dt$, where $\bar{w}$ is the input vector which generates $\bar{P}$, $\bar{P}$ is used to produce the missile's steering commands, and the integration is performed relative to a space stabilized reference frame;

(b) $\bar{U}_S = \int K_{S1} \bar{U}_S \times (\bar{U}_{SF} \times \bar{U}_S) dt$, where $\bar{U}_{SF}$ is a "trajectory shaping vector read in from fire control," $\bar{U}_S$ is used to prescribe the flight path of the missile, and the integration is performed in relation to the

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31 Claim 2 is presented in full in Appendix A, *infra*.

32 The portion of claim 2 identified as "element (c)" is presented in full, *supra*, at p. 7.

33 By saying that "the integration is relative to a space stabilized reference frame," we adopt the inventor's definitions as set forth in his specification, namely, the vector quantities of the integrand, *i.e.*, $\bar{b}$ and $\bar{Y}$, are expressed in reference to the stabilized reference frame. *See* cols. 4 and 5, lines 64-75 and 1-4, respectively.

missile's space stabilized reference frame.

With respect to the first computation (a), plaintiff interprets the claimed output vector, $\bar{b}$, to encompass the accused steering command, $\bar{P}$, and the claimed input vector, $\bar{Y}$, to encompass the accused input vector, $\bar{w}$. Although this does not result in absolute identity between the two computations even when the above identities are incorporated in the accused computation (because the accused computation incorporating the alleged identities merely becomes $\bar{b} = \int \bar{Y} \times \bar{b}\, dt$, whereas the claimed computation $\bar{b} = \int \bar{b} \times \bar{Y}\, dt$), plaintiff contends that the claimed computation is nevertheless literally infringed by the accused computation incorporating the alleged identities.[34]

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34 At first, it might appear that the two are identical since the product of a first *scalar* quantity times a second *scalar* quantity is always equal to the product of the second times the first (*i.e.*, AB = BA). However, it must be remembered that when an "X" is placed between two *vector* quantities, it is deemed to connote the mathematical operation called "cross product," not "multiplication," and the cross product between a first vector and second vector quantity does not equal the cross product between the second and first (*i.e.*, $\bar{A} \times \bar{B} \neq \bar{B} \times \bar{A}$).

Nevertheless, plaintiff's result can be justified as follows:

1) Although $\bar{A} \times \bar{B} \neq \bar{B} \times \bar{A}$, it is well known that $\bar{A} \times \bar{B} = -(\bar{B} \times \bar{A})$. *See* Shames, *Engineering-Mechanics* § 2.7 (1960). Therefore, the accused computation $\bar{w} \times \bar{P}$ is equivalent to $-(\bar{P} \times \bar{w})$.

2) Using the definition of cross product, *see* back-

In its reply, defendant does not deny that the claimed computation reads on the first accused computation (a). *See* DRSPOL § 119. Defendant does, however, maintain that the accused *apparatus* does not perform the accused computation and, therefore, that the accused *apparatus*, which is the sole subject of this infringement suit, does not infringe element (c) of claim 2. Specifically, defendant contends that a portion of the claimed computation (the mathematical operation of integration) can be performed only by an analog computer (which is what plaintiff discloses in his specification to perform the integration), and that the accused structure, being a digital computer, does not and *cannot* perform this operation. To resolve this issue, we must examine the type of computation actually performed by defendant's digital computer and then compare it with the claimed computation.

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ground mathematics discussion, *infra* at Appendix B, it can be shown that $-(\overline{B} \times \overline{A}) = \overline{B} \times -\overline{A}$. Therefore, the accused computation $\overline{w} \times \overline{P}$ is also equal to $\overline{P} \times -\overline{w}$.

3) If $\overline{Y}$ is equated to *minus* the accused input vector $\overline{w}$ (*i.e.*, $\overline{Y} = -\overline{w}$), instead of the input vector itself (*i.e.*, $\overline{Y} = \overline{w}$), then the identity between the claimed computation and the accused computation is easily seen:

$$\int \overline{w} \times \overline{P}\, dt = \text{accused computation}$$

$$= \int -(\overline{P} \times \overline{w})\, dt \text{ [under (1) above]}$$

$$= \int \overline{P} \times -\overline{w}\, dt \text{ [under (2) above]}$$

$$= \int \overline{b} \times \overline{Y}\, dt \text{ [incorporating the alleged identities]}$$

$$= \text{claimed computation}$$

Integration, as we have pointed out in the background mathematics discussion, *infra* at Appendix B, is essentially a "continuous" method of calculating and summing an infinite series of mathematical computations. Analog computers include devices known as electronic analog integrators which perform this integration operation. These electronic analog integrators operate very much like the "bucket integrators" which we discussed during our discussion of background mathematics, *infra* at Appendix B. When electronic analog integrators are used to integrate a time-varying quantity, the time-varying quantity is first converted into an electronic signal having a time-varying strength proportional to the magnitude of the time-varying quantity, and this electronic signal is then fed to the electronic analog integrator which accumulates the electronic current flow resulting from the electronic signal in very much the same way as did the "bucket integrator" in our water hose and bucket example.

The digital computer, on the other hand, *cannot* perform the continuous process which the electronic analog integrator and the "bucket integrator" perform and, therefore, can never *truly* integrate. Instead, the digital computer is programmed to *approximate* the results of an actual integration by taking periodic samples of the time-varying quantity and calculating from this an approximated value for the integral using a computation process either identical

to, or similar to, the sample method illustrated in the background mathematics discussion in Appendix B, *infra*. Just as in that example, however, the accuracy of the result achieved by the digital computer using the sample method can be made as accurate as necessary merely by increasing the frequency of the samples. The integral, however, can never be precisely calculated by the digital computer.

Thus, although it is true that the digital computer does not and cannot perform integrations, as such, defendant's digital computer has been programmed to perform a series of discrete mathematical computations designed to *simulate* actual integration, and the results of that simulation *approximate* the results of an actual integration as closely as needed. If an apparatus has been intentionally designed to *simulate* an integration, we do not think that it avoids infringement of a portion of a claim which is directed to all means which perform that integration.

First of all, although the specification discloses only analog integrators to perform the integration, the claim is not limited to any specific type of apparatus for performing the integration. As we have pointed out in our discussion of the validity of claim 2, although the specification may be properly used to *interpret* limitations *already* present in the claims, *Westwood Chemicals v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), they may never be used to impose additional or otherwise

nonexistent limitations upon those claims, *Siegler* v. *Watson*, 267 F.2d 621, 121 USPQ 119 (D.C. Cir. 1959). Moreover, there is nothing in the prior art or the file wrapper of the '052 patent which would require the claims to be limited to such a narrow interpretation.

A similar case was before this court in *Decca Ltd.* v. *United States*, 210 Ct. Cl. 546, 563-64, 544 F.2d 1070, 1979-80, 191 USPQ 439, 447 (1976), where the court rejected defendant's contention that the scope of the claim must be limited to analog computers because that was the only type computer disclosed in the specification:

> With respect to the contention that use of digital means distinguishes the accused system, it is to be noted that the claim is not by its terms, in any way limited to the specific analog mechanism disclosed. Also, the specification contains no indication that it was the configuration or details of the particular ap paratus disclosed that was considered by the patentees to be their invention. Nor is there either prior art which requires that the claims be limited to the apparatus disclosed in order to preserve its validity, or proof that the doctine of file wrapper estoppel requires such a limited construction of the claims. On these facts, infringement is not avoided by showing that digital instead of analog techniques are used in the accused system.

Thus, whether the accused apparatus is digital or analog is irrelevant to the question of infringement

under the facts of this case. The essential question is whether the accused apparatus responds to the limitations stated in the claims. We now focus our attention on this question.

We first note that an "integrator" is *not* called for as an element of claim 2. Rather, the claim merely recites "means" to express an output vector "as the integral" of another quantity. Thus, *any* means which expresses an output vector as the integral of that other quantity, be it an integrator or equivalent means, infringes this portion of the claim.

Secondly, when we interpret the meaning of the claim language in light of the specification, it becomes clear that the "means" which expresses an output vector as the integral of another quantity need not do so *precisely*. Were that not the case the claim would not even read on the disclosed preferred embodiment, for electronic analog integrators cannot calculate the integral *precisely* due to intrinsic electronic errors such as drift and offset, neither of which can be entirely eliminated. Indeed, the results achieved by defendant's high-speed digital computer programmed to *simulate* integration may *approximate* the integral more accurately than the results achieved by the rudimentary analog integrator disclosed in the patent specification.

Thus, when the claim language is read in light of the specification, *all* means which are capable of expressing an output vector *approximately* as the integral of the cross product between the output vector and the input

vector infringe element (c) of claim 2. As a consequence of this interpretation, we conclude that the first computation (a) performed by the digital computer on board defendant's Poseidon missile comes within the scope of the claim both literally and substantially.

Even assuming, *arguendo* that a case of literal infringement is not established, defendant's digital computer may still infringe element (c) of claim 2 under the judicially created doctrine of equivalents if it performs substantially the same function of the patented device, in substantially the same way, to obtain substantially the same result, *see Graver Tank & Manufacturing Co. v. Linde Air Products Co.*, 339 U.S. 605, 608, 85 USPQ 328, 330 (1950).

Although there is no question that the digital computer performs substantially the *same function* to obtain substantially the *same result*, defendant contends that it does not perform in substantially the *same way*. Specifically, defendant maintains that the digital computer simulation of integration is wholly unlike the actual integration process called for by the claim. However, as we have concluded in our discussion of integration, the sample method used by the digital computer to simulate actual integration is very much like the actual integration process itself. It differs in that the time period of measurement is microfinite rather than infinitesimal, a difference which in our minds is insufficient to legally distinguish the use of a

digital computer from the "means" broadly encompassed by the claim language.

What is perhaps most significant to this question is the fact that this is *not* a case where an apparatus is accused of performing a function which merely accidentally is similar to a claimed function, but a case where the apparatus is *intentionally designed* to simulate that function. As proof of this, one need only look at the manual which described the operation of defendant's Poseidon missile. A chart in the manual shows a number of "Steering Equations" which expressly include the mathematical symbol for integration, "$\int$". *See* plaintiff's exhibit no. 23 (filed February 27, 1978). Defendant cannot program a digital computer to *simulate* integration and then say that the programmed digital computer does not perform an operation *equivalent* to integration. Accordingly, we conclude that, even if not literally infringed, under the doctrine of equivalents defendant's digital computer, being programmed to simulate the first computation (a), is encompassed by the terminology used to define element (c) of claim 2 and, to that extent, infringes that claim.

With respect to the second computation (b), plaintiff interprets the claimed output vector, $\bar{b}$, to encompass the accused flight path control vector, $\bar{U}_S$, and the claimed input vector, $\bar{Y}$, to encompass K_{S1} times the cross product between the accused trajectory shaping vector, $\bar{U}_{SF}$, and the accused flight path control vector,

$\bar{U}_S$ (*i.e.*, $\bar{Y} = K_{S1}(\bar{U}_{SF} \times \bar{U}_S)$).[35] When these identities are incorporated into the accused computation, it becomes identical with the claimed computation.[36]

In defendant's reply to this allegation, although he does not dispute that the claimed computation is infringed by the second accused computation, *see* DRPOL ¶ 119, defendant does maintain the same defense that he did with respect to the first accused computation (a) *i.e.*, that the accused apparatus, a digital computer,

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35 That the scope of the claimed input vector, $\bar{Y}$, is broad enough to encompass $K_{S1}(\bar{U}_{SF} \times \bar{U}_S)$ is demonstrated by just such an identity in the specification. Specifically, the specification states that: "Since the input vector $\bar{Y}$ is open to choice, it can be stated as: $\bar{Y} = \bar{Z} \times \bar{b}$ where $\bar{Z}$ is a given vector," col. 2, lines 44-46, and "$\bar{Z}$ [may be] expressed as: $\bar{Z} = \alpha\bar{g}$," col. 4, lines 10-11. Thus, the specification states that $\bar{Y} = \bar{Z} \times \bar{b} = (\alpha\bar{g}) \times \bar{b} = \alpha(\bar{g} \times \bar{b})$ which is of the same form as $K_{S1}(\bar{U}_{SF} \times \bar{U}_S)$.

36 Actually, the accused computation is not directly susceptible to incorporation of the alleged identities because the identity for $\bar{Y}$, (*i.e.*, $K_{S1}(\bar{U}_{SF} \times \bar{U}_S)$) does not appear directly in the accused computation. Nevertheless, the accused computation can be easily manipulated into a form susceptible to the incorporation of the alleged identities. The following manipulation is all that is needed:

$$\begin{aligned} \int K_{S1}\bar{U}_S \times (\bar{U}_{SF} \times \bar{U}_S)dt &= \text{accused computation} \\ &= \int \bar{U}_S \times K_{S1}(\bar{U}_{SF} \times \bar{U}_S)dt \\ &= \int \bar{b} \times \bar{Y}\, dt \text{ [incorporating the alleged identities]} \\ &= \text{claimed computation} \end{aligned}$$

does not and cannot perform the second accused computation (b). We, however, maintain the same conclusion here that we did with respect to the first accused computation (a), namely, that such a distinction is without legal significance under the facts of this case and conclude, therefore, that defendant's digital computer programmed to *simulate* computation (b) also infringes element (c) of claim 2.

2. *Element (a) of Claim 2*

The expression of a vector quantity must always be in reference to a frame of reference to give that expression meaning. *See* Appendix B, *infra*. The purpose of element (a) of claim 2,[37] "a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity," is to serve as this frame of reference.

"[A] physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity" is a specific type of reference frame known as a "space-stabilized" reference frame. A "space-stabilized" reference frame is a reference frame which maintains a constant angular position relative to space even though the angular position of its supporting harness may change relative to space.

One technique used to "space-stabilize" a reference

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[37] The full text of claim 2 is presented in Appendix A, *infra*.

frame, the technique called for by claim 2, is to use "means of sensing and suppressing its angular velocity." What this means is that "means" are connected to the reference frame which sense its rotational movement relative to space (*i.e.*, its "angular velocity") and, in response to the sensed rotational movement, suppress that movement by rotating the reference frame back to its original position relative to space. Thus, although the "space-stabilized" reference frame may be mounted within a rotating structure (such as a missile rotating about its trajectory axis), the angular postion of the "space-stabilized" reference frame relative to space will not change.

Defendant has tacitly conceded that the vector quantities used in the Poseidon missile computations discussed above are referred to a space-stabilized reference frame (*see* PMSJ at p. 8 and DRPMSJ at p. 43), and that this reference frame is defined by a mutually orthogonal set of reference axes labeled sr, j and sv (*see* PSPOL and DSPOL at ¶ 2, 13, and 21). Defendant denies, however, that the reference frame defined by axes sr, j, and sv are "physically defined" within the meaning of that language as used in element (a) of claim 2 and, therefore, denies that this element is infringed by the Poseidon missile. Rather, defendant states that "it is more satisfactory to consider the reference frame [defined by axes sr, j, and sv] as a mental picture rather than a physical object." (DSPOL at p. 5.)

To support its contention that the space stabilized reference frame defined by axes sr, j, and sv is physically defined, plaintiff relies upon a description of defendant's Poseidon missile contained in a Poseidon missile teaching manual, PL-EX 22. In this manual, plaintiff first points to language allegedly showing that the Inertial Reference Subsystem, a component of the Poseidon missile, is "a physically defined, stabilized reference frame having means of sensing and suppressing its angular velocity":

> 3.2.1 (U) INTERTIAL REFERENCE SUBSYSTEM. The basic function of the inertial reference subsystem, figure 3-4, is to provide a *stable platform* for the acceleration measurement subsystem and to provide a reference platform for missile attitude control. As shown in figure 3-4, the inertial reference subsystem comprises three gyros, three gyro output amplifiers (in one module), a gyro error resolver, three gimbal servo modules, five torque motors, three tachometers, and three gimbals. *The three gyros in the gimbal-mounted stable platform provide error signals indicating angular displacements of the platform with respect to inertial space.* The error signals are amplifed by the gyro output amplifier and the gimbal servo modules and *the amplifier outputs are used to drive the gimbal torque motors to null the platform angular displacement.* [PL-EX 22 at Change 2, Rev. 1, p. 3-3 (emphasis added)].

Plaintiff apparently equates the "stable platform" with "a physically defined, stabilized reference frame" and the means for "indicating angular displacement of the platform with respect to inertial space" and the means to "null the platform angular displacement" with the "means of sensing and suppressing [the reference frame's] angular velocity."

To demonstrate that the axes sr, j, and sv are physically defined, plaintiff points to the portion of the manual which states:

> The acceleration measurement [using the stable platform of the Inertial Reference Subsystem] is accomplished by three pulsed integrating pendulous accelerometers (PIPA's) *mounted on* the computing *axes* (sr, J and sv). [PL-EX 22 at Change 7, Rev. 1, p. 2-4 (emphasis added)].

Plaintiff argues that this language demonstrates that the sr, j, and sv axes are *physically* defined for it is not possible to "mount" an accelerometer on a "mental picture."

As further evidence of the physically defined nature of axes sr, j, and sv, plaintiff brings to the attention of the court the following passage from the Poseidon missile manual:

> The function of the acceleration measurement subsystem, figure 3-5, is to measure changes in velocity in terms of the components of velocity along the slant range (sr), slant vertical (sv), and cross-

range (j) axes. [*Id.* at Change 2, Rev. 1, P. 3-3.]

The significance of this statement, as plaintiff has pointed out, is that the acceleration measurement subsystem, a piece of hardware, measures *physical* changes in the orientation of the sr, j, and sv axes, measurements which could not be made upon a "mental picture."

Finally plaintiff quotes the following language from the Poseidon missile manual to further demonstrate that the sr, j, and sv axes must be physically defined:

> Dual windings of the gyro signal generator [a part of the Inertial Reference Subsystem] provide components of sr, j and sv axis rotation. [*Id.*]

Plaintiff contends that the gyro signal generator can only generate rotation measurements of the sr, j, and sv axes if those axes are *physically defined*, for a piece of hardware cannot be used to measure the rotation of a "mental picture."

We think that this evidence is sufficient to demonstrate that the space stabilized reference frame defined by axes sr, sv, and j in the Poseidon missile is *physically* defined insofar as it is embodied in the acceleration measurement subsystem.

To support the contrary position that Poseidon's reference frame is merely a "mental picture," defendant has not offered a single piece of evidence. Moreover, defendant has not even offered the slightest explanation of what defendant means by a "mental

picture," how it is created, how an accelerometer and a gyro signal generator can measure physical attributes of the "mental picture," or how an accelerometer can be "mounted on" the purported "mental picture." Indeed, in the entire record to date, the only statement made by defendant concerning the sr, sv, and j axes, if anything, supports plaintiff's contention that these axes are *physically* defined. Specifically, in response to plaintiff's contention that the axes were physically defined, defendant stated:

> Though it is true that the accelerometers are mounted with their sensitive axes close to the SR, J and SV axes, the measurement of misalignment between the accelerometer sensitive axes and the SR, J and SV axes clearly indicates the distinction between these two. [DRPOL, ¶ 2.]

Although defendant offered no evidence to support its statement that a "measurement of misalignment between the accelerometer sensitive axes and the SR, J and SV axes" was made in the Poseidon missile system, even assuming the statement to be accurate, as plaintiff has pointed out, it does not support the theory that these axes are *not* physically defined:

> Defendant rightfully speaks of the *measurement* of misalignment *between* the accelerometer sensitive axes and the SR, J and SV axes * * *." The misalignments exist and are measurable exactly because the axes SR, J and SV exist as independent,

physical entities. [PRSPOL, ¶ 2, emphasis added.]

This court is well aware that a motion for summary judgment may not be granted where a genuine issue of material fact is in dispute, *see e.g., Nicholas A. Garcia, Jr.* v. *United States*, 123 Ct. Cl. 722, 732 (1952). However, once a moving party has introduced sufficient evidence to support his allegation, the burden of proceeding shifts to the opposing party and a mere formal denial unsupported by evidence or even explanation is wholly insufficient to place such issue of material fact in dispute and, therefore, is insufficient to prevent the award of summary judgment. *See Royal Indemnity Co.* v. *United States*, 178 Ct. Cl. 46, 371 F.2d 462, *cert. denied*, 389 U.S. 833 (1967). Accordingly, because we believe that the evidence offered by plaintiff is sufficient to demonstrate that the space reference frame defined by axes sr, sv, and j is physically defined, and because defendant has done nothing more than merely deny this fact, we conclude that element (a) of claim 2 is infringed by defendant's Poseidon missile.[38]

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[38] Even at the lengthy oral argument on the present motion, defendant was unable to satisfy the trial judge that the *facts* upon which the foregoing conclusion is based are in dispute or that defendant would adduce more or different *facts* in the event a trial was to be held on this issue.

3. *Element (b) of Claim 2*

The last element of claim 2,[39] element (b), calls for "means of obtaining a plurality of input signals in representation of any desired values, said input signals being referred to said reference frame to express an input vector." Whle defendant appears to admit that its Poseidon missile has a similar type of means, defendant contends that, for some of these vector quantities, the "representation [of them in the Poseidon missile] is quite unlike that of plaintiff's vectors. They take part in a series of computation performed by a general purpose digital computer." DRPMSJ, p. 43. What defendant appears[40] to mean by this is that the *form* of the representation of the value of the vector's coordinates in Poseidon's digital computer is different from the *form* of their representation in the analog computer disclosed in the patent specifications. However, although it is true that the *forms* of representation are different,[41] no particular form of vector

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39 The full text of claim 2 is presented in the Appendix A, *infra*.

40 We say "appears" because defendant has again failed to adequately explain its position.

41 The value of a vector coordinate in an analog computer is represented by a *single* electrical signal having a voltage proportional to the value of the vector coordinate. The value of a vector coordinate in a digital computer, on the other hand, is represented by a *plurality* of electrical signals having only one of two

coordinate representation is specified in the claim and there is nothing in the prior art or in the prosecution history of the patent which would require the scope of the *claims* to be limited to the particular *form* disclosed in the patent *specifications*. As we have already pointed out, although the specification may be properly used to *interpret* limitations already present in the claims, *Westwood Chemicals, Inc. v. United States*, 207 Ct. Cl. 791, 525 F.2d 1367, 187 USPQ 656 (1975), the specification may never be used to *add* other or otherwise nonexistent limitations to those claims, *Siegler v.*

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possible voltages depending on the value of the vector coordinate. This later form of representation is known as a "digital" representation while the former is known as an "analog" representation.

While the representation of the value of a vector coordinate in analog form may be intuitively appreciated, its representation in digital form may be appreciated only after the nature of a "digital" signal is understood.

A "digital" signal derives its name from the fact that the signal is representative of a *digit*, whereas an "analog" signal is representative of a *value*. The difference is illustrated by the following example: If the *value* of a vector coordinate were 7214, this could be represented by a single "analog" signal having a voltage proportional to the *value* of that coordinate (*e.g.*, the "analog" signal might be 7214 volts). On the other hand, because a "digital" signal can only represent *digits*, it would take a set of four "digital" signals to represent the *value* of the vector coordinate (*i.e.*, one "digital" signal for each *digit* of the *value*.

The nature of "digital" signals is further distinguished from "analog" signals in that a "digital" signal is com-

Watson, 267 F.2d 621, 121 USPQ 119 (D.C. Dir. 1959). Accordingly, we conclude that the Poseidon missile infringes element (b) of claim 2.

Having concluded that defendant's Poseidon missile infringes each and every element of claim 2, plaintiff's motion for summary judgment for infringement of claim 2 by defendant's Poseidon missile is granted.

Claim 3[42] is similar to claim 2 except that it defines the axes of the "physically defined, stabilized reference frame" to be "denoted by the numerals 1, 2, and 3" and calls for "means of obtaining an input signal * * * being referred to said axis 3 to express an input vector." Plaintiff contends that because this language fails to state anything about the other two components

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monly capable of representing *only* the digits "1" or "0". Thus, to represent the value of a vector coordinate by a "digital" signal, the value must first be expressed only in terms of "1s" or "0s". This merely requires the conversion of the value from its base 10 decimal form (the base we normally think of) into a base 2 binary form, a problem easily solved using elementary mathematics. The voltage of the "digital" signal is then normally set to a high level if the digit to be represented is a "1" or to a low level if the digit to be represented is a "0".

Thus, in the above example the digital representation of the vector coordinate value 7214 (which in "binary" equals 1110000101010) would require 13 electrical signals (one for each binary digit) set to the appropriate voltage level. This is contrasted to the single electrical signal which might be set to 7214 volts to represent the value in an analog computer.

[42] The full text of claim 3 is presented in Appendix A, *infra*.

of the input vector, *i.e.*, Y_1 and Y_2, claim 3 is broader than infringed claim 2 and therefore *a fortiori* infringed by defendant's Poseidon missile. Defendant, on the other hand, contends that claim 3 implicitly requires that two of the components of the input vector, *i.e.*, Y_1 and Y_2, must be consistently zero and that, since the Poseidon missile does not operate this way, it does not infringe claim 3. For the following reasons, we agree with defendant:

A portion of the language in claim 3 states that while the computation $\overline{b} = \int \overline{b} \times \overline{Y}\, dt$ is being performed, the "output vector is driven by the said input vector to rotate around the said axis 3." However, because the output vector, $\overline{b}$, always rotates around the input vector, $\overline{Y}$, whenever this computation is performed,[43] the input vector, $\overline{Y}$, must be in coalignment with axis 3. This can only happen, however, when the components of the input vector, $\overline{Y}$, along axes 1 and 2 are constantly zero. Therefore, the language of claim 3 requires by

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[43] Plaintiff has stated that all of the claims in suit "cover every functional result that is producible in an output direction." Plaintiff's Answers to Defendant's Interrogatories, ¶ 4b, 5 (filed June 21, 1976). These "functional results" are described in the specifications. One is that "the output [vector] rotates *around* the input vector to describe a conical surface" and the other is that "the output [vector] rotates *directly towards* the input vector and *seeks coalignment*" (which by implication means that it must rotate *around* the input vector until it becomes coaligned) col. 1, lines 21-32. Thus, the output vector always rotates *around* the input vector during performance of the claimed computation.

implication that two of the three components of the input vector be of zero value.

This conclusion is fortified by the fact that our interpretation of the claim is supported in the specifications by the following language:

> If, also, by the nature of the input vector in the particular reference frame utilized, one or two of the input vector components are consistently zero, all the computations regarding them in that reference frame go out. [Col. 9. lines 30-34.]

Moreover, no language could be found in the specification which supports plaintiff's interpretation of the claim language. Accordingly, because plaintiff has not demonstrated that two of the three input vector components are *consistently* zero in defendant's Poseidon missile, plaintiff's motion for summary judgment for infringement of claim 3 by defendant's Poseidon missile is denied.

The parties agree that claim 6[44] is identical to infringed claim 2, except for the following additional elements:

> (d) a second reference frame defined with respect to the said stabilized frame by means to perform a coordinate transformation therebetween,

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[44] The full text of claim 6 is presented in Appendix A, *infra*.

(e) the input signals being referred to the second reference frame to express an input vector, and

(f) The "means" receiving the input signals and generating the output signals to include the coordinate transformation means in (d) above. [*See* PRDRA at ¶ 21.]

To support plaintiff's contention that the Poseidon missile also infringes claim 6, plaintiff brings to the attention of this court the following language in the Poseidon missile manual:

> *These signals* [making up vector $\bar{P}$] *are* converted from digital to analog, *coordinate transformed*, and multiplexed in flight control. *They are coordinate transformed again* by the coordinate transformation resolver chain, and used by flight control to control missile attitude. [PL EX 22 at Rev. 1, p. 202 (emphasis added)].

Defendant's sole opposition to this allegation is that:

> [S]ince this [allegation] builds on [the allegation that claim 2 is infringed by the Poseidon missile] with which we disagreed, we disagree with this [allegation]. [DRSPOL at ¶ 41.]

It is clear, therefore, that defendant does not contend that Poseidon does not infringe claim 6 because it lacks the additional elements of claim 6 not found within claim 2. Rather, defendant's sole opposition to an allegation of infringement is based on its contention

that the Poseidon missile lacks the elements of claim 6 common to claim 2, or in other words, that the Poseidon missile does not infringe claim 2. In view of our contrary ruling on this point, however, plaintiff's motion for summary judgment for infringement of claim 6 by defendant's Poseidon missile is, therefore, granted.

Claim 7[45] is identical to claim 6 except that it incorporates the same language which distinguished claim 3 from claim 2. Accordingly, for the same reasons we failed to find claim 3 infringed by defendant's Poseidon missile, we find claim 7 also not infringed and, therefore, deny plaintiff's motion for summary judgment for infringement of claim 7 by defendant's Poseidon missile.

In summary, based upon our interpretation of the claims and the evidence submitted by the parties relating to the accused Poseidon missile, we have concluded that plaintiff's motion for summary judgment for infringement by defendant's Poseidon missile should be granted with respect to claims 2 and 6, but should be denied with respect to claims 3 and 7.

3. *Application of the Claims to Trident*

Evidence on the structure of defendant's Trident missiles, on the other hand, has not been introduced due to classification encumbrances. Nevertheless, the par-

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[45] The full text of claim 7 is presented in Appendix A, *infra*.

ties have stipulated that, for the limited purpose of this suit, the structural portions of the Trident missile relevant to the question of infringement are identical or equivalent to the corresponding structural portions of the Poseidon missile.[46] Accordingly, plaintiff's motion for summary judgment for infringement by defendant's Trident missile is also granted with respect

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46 The equations implemented on the Poseidon missile which we have previously analyzed were copied from page 2-87 of document LMSC-D-052305. The corresponding equations implemented on Trident, however, were considered by defendant to be classified and, therefore, not subject to examination in open court. Plaintiff, however, contended that this information was not properly subject to classification, but advised defendant that the dispute could be settled if the Government would stipulate that the Trident missile implements these equations identically or equivalently as Poseidon. In response to this request, Admiral Levering Smith wrote a letter to the Chief of Naval Research on August 9, 1977, stating: "Mr. Arshal advised that if the government will validate the fact that the TRIDENT missile system implements these equations identically or equivalently as POSEIDON the debate over classification will have been ended. * * * [O]ur determination meets the request of Mr. Arshal * * *."

Then in plaintiff's brief supporting its motion for summary judgment (filed April 7, 1978), plaintiff stated that Admiral Levering Smith's letter was "intended to satisfy plaintiff's request for a stipulation that 'validate[s] the fact that the Trident missile system implements these steering equations identically or equivalently as Poseidon.'" Because defendant's reply brief (filed May 18, 1978) did not dispute this alleged stipulation, we have concluded that defendant does not disagree with it.

to claims 2 and 6, but is also denied with respect to claims 3 and 7.

VI. *Summary and Conclusion*

While most courts are reluctant to grant summary judgment in patent cases involving technically sophisticated subject matter, *see e.g., Xerox Corp. v. Dennison Manufacturing Co.*, 332 F. Supp. 963, 966-67, 168 USPQ 700, 703 (S.D.N.Y. 1971), it is well established that summary judgment is permissible when the court can understand the relevant technology without the aid of expert opinion, *see e.g., Grayson v. McGowan*, 543 F.2d 79, 192 USPQ 571 (9th Cir. 1976). In the present case, the voluminous body of instructional materials offered in evidence by both parties, the helpful comments offered at the extensive and thorough oral hearing on the motions, and this court's substantial experience with patent law cases, has enabled the court to sufficiently comprehend the subject technology to render a technically sound decision without hearing the testimony of technical expert witnesses.

Our analysis of the claims in suit and the accused structures has led us to conclude that, although claims 2 and 6 are infringed by defendant's Poseidon and Trident missile systems, all of the claims in suit fail to define an invention which is susceptible to patenting under 35 U.S.C., § 101 and are, therefore, invalid. In view of this finding, we have decided that it is unnecessary to rule on plaintiff's motion for summary

judgment on the license issue or other issues raised by either party.

For the reasons set forth herein, defendant's motion for summary judgment on the dispositive issue of invalidity is allowed, and plaintiff's motion for summary judgment on the issue of infringement is allowed as to claims 2 and 6, if not moot, and is denied as to the issue of validity. The petition is dismissed.

APPENDIX A and APPENDIX B

These appendices are identical with those of Appendix 1 at pages 32a and 34a.

APPENDIX 3

IN THE UNITED STATES COURT OF CLAIMS

No. 431-75

(Filed June 27, 1980)

GEORGE ARSHAL

v.

THE UNITED STATES

Before: KASHIWA, *Judge*, presiding, KUNZIG and BENNETT, *Judges*.

ORDER

This case comes before the court on plaintiff's motion, filed May 23, 1980, for rehearing *en banc* pursuant to Rules 7(d) and 151(b) and on plaintiff's motion for stay of all proceedings, filed May 6, 1980, with reference to the decision entered herein on March 19, 1980. Upon consideration thereof, together with the responses in opposition thereto, without oral argument, by the seven active Judges of the court as to the suggestion for rehearing *en banc* under Rule 7(d), which suggestion is denied, and further having been so considered by the panel listed above as to the motion for rehearing under Rule 151(b) and as to plaintiff's motion for stay of all proceedings,

IT IS ORDERED that plaintiff's motions for rehear-

ing and for stay of all proceedings be and the same are denied.

BY THE COURT

Shiro Kashiwa
Judge, Presiding